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IN SENATE,

JANUARY, 1892.

ANNUAL REPORT

OF THE

STATE GEOLOGIST.

OFFICE OF THE STATE GEOLOGIST,
ALBANY, *January*, 1892.

To the Legislature of the State of New York:

In pursuance of chapter 247 of the Laws of 1888, I have the honor to transmit to the Legislature the Eleventh Annual Report of the State Geologist for the year 1891.

Very respectfully.

JAMES HALL,

State Geologist.

CONTENTS.

PAGE.

1. Letter of transmission 3
2. Table of contents 5
3. Eleventh Annual Report of the State Geologist 7
4. Livonia salt shaft 10
5. Palæontology of New York 12
6. List of Preparations of Spirals, Loops and Hinge-plates 14
7. List of genera of the Palæozoic Brachiopoda 15
8. Additions to the Palæontological collections 22
9. Catalogue of the collection donoted by the Albany Institute 33
10. Report of the Assistant Palæontologist 54
11. List of the Original and Illustrated specimens in the Palæontological collections 57
12. Record of Localities of Extra Limital Geological and Palæontological collections of the New York State Museum 122
13. On Cordania, a Proposed New Genus of Trilobites by J. M. Clarke 124
14. Handbook of the Brachiopoda 133

REPORT.

To the Honorable the Legislature of the State of New York:

During the past year, as in the several preceding years, the time of the State Geologist has been almost entirely devoted to the collection, preparation, systematic arrangement and study of material for, and the preparation and publication of the Paleontology of New York. Volume VIII is now in press and the printing had progressed to more than 300 pages in February last, since which time no printing has been done. The manuscript for the completion of the volume, and that for the explanation of the plates has been ready for the printer since before that date, and nearly all of it was in hand at the time of suspension of printing. The plates for the illustration of the work are all completed.

The condition of this work, both as regards the volume in press and the preparation of the material, manuscript, drawings and lithographic plates for the succeeding portion of the work on volume VIII, part ii, will be given in detail further on.

During the past year it has been necessary to turn aside from this work to give attention to a subject of much interest and importance to our knowledge of the character, mineral and fossil contents and succession of the strata in central New York, from the horizon of the Genesee slate to the Salt group of Onondaga.

In November last the State Geologist received a letter from M. L. Townsend, Vice-president of the Livonia Salt and Mining Company, of Livonia, Livingston county, and of Broadway, New York, of which the following is a copy:

LIVONIA SALT AND MINING COMPANY,
LIVONIA, N. Y., *November* 3, 1890.

The Honorable the State Geologist, Albany, N. Y.:

DEAR SIR.— We are engaged in sinking a shaft 12 by 24 feet at this place for the purpose of mining salt. The depth of the shaft will be about 1400 feet, and we have to go through from 600 to 700 feet

of shale rock, and about the same thickness of lime rock, consisting of a stratum of Corniferous and also of Helderberg. Both the shale and the lime rock will contain many interesting and perhaps valuable specimens which your department may desire to obtain. If so, we will be glad to aid you in securing them, and to render you facilities for examinations of the rock formations if you wish to make them.

Respectfully yours.

(Signed.) M. L. TOWNSEND,

Vice-president.

To this letter I replied, thanking Mr. Townsend in behalf of the State for his interest in the subject and the consideration he had shown, and expressing myself very desirous of taking advantage of his kind offers. In reply to my letter I received the following:

LIVONIA SALT AND MINING COMPANY,
LIVONIA, N. Y., *November* 10, 1890.

Hon. JAMES HALL, *State Geologist:*

DEAR SIR.— Answering your inquiries of the sixth instant, I beg to state that our shaft is now down about seventy feet, and we have just entered the shale rock. We will be somewhat delayed for a few days in the erection of machinery, but in about two weeks we intend to be blasting in the rock, and to continue the work day and night. It will take about two years to complete the shaft.

Respectfully yours.

(Signed.) M. L. TOWNSEND.

I brought this subject before the secretary of the Regents, with my own advocacy of the work, but as there appeared to be no money available for such purposes nothing was done. The subject was again brought before the Regents at their annual meeting in December and the following resolution was offered by Regent Harris at the meeting of the committee on the State Museum, the same being afterwards voted unanimously by the Regents:

"That the Legislature be asked to appropriate $1,000 a year for two years to meet the expense of securing specimens and making records of the geological formation in the shaft to be sunk 2,000 feet at Livonia."

A copy of this resolution was sent by Secretary Dewey to the chairman of the committee of ways and means of the Assembly on March 10, 1891, but as the committee had already reported the supply bill no action could be taken. Subsequently a bill was introduced into the Assembly* providing for the completion of the Paleontology and the Geological Map and making provision for the work on the Livonia salt shaft, in the following terms:

"To enable the State Geologist to accept the offer of the Livonia Salt Company, to allow the State without charge to make records of the geological formation and to select specimens of value found in the salt shaft, covering 12x22 feet, which the company is now sinking to the depth of 2,000 feet, at Livonia, the sum of $2,000."

The bill after having passed the House was met by the deadlock in the Senate and failed to become a law. I then proposed to expend, for the purposes of the Livonia shaft exploitation, the money which had been apportioned from the general Museum appropriation for the geological and paleontological work of the year, which sum I was informed was about $800.

I then went to Livonia to examine the situation and facilities for the work, and after some preliminary arrangement with the manager of the work I sent for Mr. D. D. Luther, of Naples, with whom I had had previous correspondence regarding the undertaking. I made an arrangement with Mr. Luther to remain on the ground and to examine the rock as brought out of the shaft; to keep a record of the progress of the work; to note the nature of the rock passed through, its changes of character and to collect the fossils from the same, recording their relative depth from the surface, and other facts of interest or importance.

Unfortunately for the completeness of our record, the work in the shaft had already progressed to the depth of 350 feet before this arrangement had been consummated, and we have only been able to collect the data for that portion of the shaft from the materials upon the dump. However, we have ascertained that after passing through about sixty-eight feet of drift material (clay and gravel) the rock excavation was begun in the upper part of the Genesee slate, and the materials obtained from the output have been sufficient to complete the record, in a general way, to the

* Assembly bill 1441.

point when the daily observations of the work began from the actual excavations in progress. The shaft has now progressed to the depth of about 750 feet, and we have full records of the strata passed through since the last week in May of the present year. Large collections of fossils have been made and twenty-eight boxes of specimens have been sent down to the State Hall. Some of these boxes have been opened and the contents examined, as noticed in the accompanying communication from Prof. Clarke. The final result will bring to the Museum collections a large amount of material from authentic horizons, and the observations made during their collection will show the vertical distribution of the species, and give us important information regarding the condition of the seabottom and the accumulation of sediments during this period.

It has not been thought desirable to compile a section of the rocks, with notes on their contained fossils, at this time, but the accompanying list of species will give some information of interest. This work when completed, and the fossils compared with the nature and succession of the deposits, will form an interesting chapter in the geological history of the State.

LIVONIA SALT SHAFT.

Fauna of the Hamilton shales from the base of the Genesee, at 225 feet to a depth of 350 feet. Rocks soft, compact bluish shale, crumbling rapidly on exposure; with occasional very thin calcareous bands.

Abundant and characteristic.

Phacops rana,
Cryphaeus Boothi,
Homalonotus Dekayi,
Glyptodesma erectum,
Ambocoelia umbonata,
Lingula punctata.

Common.

Platyostoma lineatum,
Aviculopecten princeps,
A. scabridus,
Actinopteria decussata,
Grammysia arcuata,
Spirifer mucronatus,
S. audaculus,
Chonetes scitula,
Dignomia alveata,
Streptelasma rectum,
Michelinia stylopora,
Polypora multiplex,
Stictopora incisurata.

Occasional.

Proetus macrocephalus,
Orthoceras nuntium,
Tentaculites bellulus,
Styliolina fissurella,
Platyceras subrectum,
P. symmetricum,
Aviculopecten scabridus,
A. exactus,
Pterinopecten undosus,
Lyriopecten orbiculatus,

Grammysia alveata,
G. bisulcata,
Palaeoneilo tenuistriata,
P. fecunda,
P. plana.
Strophodonta junia,
S. inaequistriata,
Streptorhynchus arctostriata,
Productella spinulicosta,
Spirifer Marcyi,
Atrypa spinosa,
Leiorhynchus quadricosta,
Modiomorpha concentrica,
Goniophora angulata,
Cypricardinia indenta,
Tellinopsis subemarginata,
Orthonota undulata,
O. parvula,
Microdon tenuistriata,
Prothyris lanceolatus,
Atrypa reticularis,
Athyris spiriferoides,
Spirifer sculptilis,
Tropidoleptus carinatus,
Strophodonta perplana,
Pholidops Hamiltoniæ,
Orbiculoidea media,
Lingula Delia,
L. maida,
L. ligea,
L. densa,
L. sp. nov.,
Fenestella sp?
Glauconome carinata,
Heliophyllum Halli,
Amplexus intermittens.

Rare.

Bellerophon Leda,
Aviculopecten ornatus,
Modiomorpha macilenta,
M. concentrica,
Lunulicardium? sp. nov.,
Cryptonella planirostra,
Terebratula Ontario,
Strophodonta concava,
Chonetes coronata,
Orthis Vanuxemi,
Orbiculoidea humilis,
O. grandis,
Goniatites uniangularis,
Leptodesma Rogersi,
Spirifer granuliferus,
Pentamerella papilionensis,
Favosites Argus,
Reptaria stolonifera,
Chaetetes fruticosus,
Dictyonema Hamiltoniæ,
Platycrinus sp?

The included thin calcareous bands contain

Proetus macrocephalus,
Platyceras symmetricum,
Actinopteria decussata,
Spirifer fimbriatus,
S. granuliferus,
S. medialis,
Lichenalia vesciculata,
Stictopora incisurata.

Before commencing the shaft a boring* was made through the strata to the depth of 1,507 feet. The records of this boring are as given below:

	Feet.	Feet.
Clay, gravel and sand	56	56
Shale rock	464	520
Sand rock	10	530
Shale rock	302	832
Corniferous limestone (flint rock)	133	965
Hydraulic limestone	45	1,010

* The locality of the boring is about 1,000 feet distant from the shaft opening, in a northerly direction.

	Feet.	Feet.
Limestone	313½	1,323½
Shale and salt	11½	1,335
Pure salt	35	1,370
Salt and shale	8	1,378
Pure salt	15	1,395
Soft shale	116	1,507

The bottom of the shaft is now nearing the base of the Hamilton group, and we may expect within a few days that the Corniferous limestone will have been reached.

The observations made in the progress of this shaft will serve not only as a guide in other similar works to be undertaken in the salt bearing area within the State, but they will serve to prove the nature and thickness of some of the strata in Central New York, which can not so well be determined from the exposures on the natural outcrops of the formations.

Should the work in the shaft be continued and kept up at the rate which it has been going on during the past ten months, the final result may be reported before the end of 1892.

The money made available by the arrangement already mentioned proved to be only about $600 and at the time of this writing, expenses had already been incurred to more than that amount, and some other means must be devised for the continuance of the work.

In my report of last year I gave a pretty full account of the condition of the work upon the Paleontology of the State, volume VIII, pt. i, being then in press and printed to more than 250 pages. The printing was continued till February when there were in type over 300 pages and the remainder of the manuscript in hand or ready for the printer. At this point the printing ceased, ostensibly for want of means to go on with the work, the money originally appropriated having been expended, and since that time till the present writing no arrangement has been made for the continuance of the work. Had the printing gone on from February as in the preceding few months the volume would have been published in April last. It is certainly a great misfortune to the author and to the State, as well as to the entire scientific public, that the publication of this work should have been so long delayed, when the expenditure of $1,000 would have completed the volume.

In the meantime, and for a large portion of the past year the writer, with the aid of the regular assistant in Paleontology, Prof. Clarke, and a special private assistant, Mr. Schuchert, has been occupied in bringing together and preparing material in the way of collections; the general bibliography and the special discussions upon the genera for the second part of volume VIII.

As already stated, volume VIII, part i, has been put into type to over 300 pages, and will be completed in about 350 pages exclusive of index, which has been prepared as far as the printed matter has been paged.

Of the text of volume VIII, part ii, 207 manuscript pages have been prepared. This is equivalent to about 125 pages of printed matter. Nearly twice as much more will be required to complete the discussions. In addition to the manuscript prepared, about ninety pen-and-ink drawings for the text have been made to show the structure of the spirals and loops, etc., in various genera.

Volume VIII, part i, will contain forty-two lithographic plates, numbered as follows:

I. Inarticulata: I, II, III, IV, IVA, IVB, IVC, IVD, IVE, IVF, IVG, IVH, IVK.

II. Articulata: V, VA, VB, VC, VI, VIA, VII, VIIA, VIII, IX, IXA, X, XI, XIA, XIB, XIC, XII, XIII, XIV, XV, XVA, XVB, XVI, XVII, XVIIA, XVIII, XIX, XX.

With the exception of Plate XX, all have been printed, and that one lithographed and proved.

Of the plates to accompany part ii, the following have been printed: XXI, XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII, XXX, XXXI, XXXII, XXXIII, XXXIV, XXXV, XXXVI.

The following have been drawn on stone and proved: XXIX, XXXVII, XXXVIII, XL, XLVIII, and the following are lithographed but not yet proved: XLI, XLII, XLIII, XLIV, XLV, XLVI, XLVII.

The drawings on hand are sufficient to furnish the lithographer with four plates, and a few additional drawings will be sufficient to complete ten more. For the full illustration of the volume it will require from twenty to twenty-five plates in addition to these, and will necessitate the making of from 400 to 500 new drawings.

THE FOLLOWING IS A LIST OF PREPARATIONS OF SPIRALS, LOOPS AND HINGE-PLATES.

[Made by Prof. J. M. CLARKE, for volume VIII., part ii.]

1. Spirifer radiatus	8	47. Charionella scitula	4
2. S. medialis	1	48. Bifida lepida	5
3. S. Whitneyi	1	49. Kayseria lens	7
4. S. perlamellosus	1	50. Hindella Prinstana	1
5. S. Orestes	2	51. H. umbonata	8
6. S. subumbona	1	52. Nucleospira concinna	12
7. S. Niagarensis	2	53. N. ventricosa	2
8. S. crispus	2	54. N. pisiformis	8
9. S. perplexus	2	55. N. elegans	1
10. S. Oweni	14	56. Retzia Adrieni	7
11. S. gregarius	8	57. R. Barrandii	1
12. S. arenosus	18	58. R. evax	15
13. S. pennatus	2	59. R? sobrina	1
14. S. granuliferus	1	60. R? longirostris	2
15. Amboccelia umbonata	10	61. Rhynchospira formosa	6
16. Crytina umbonata	5	62. R. sp?	11
17. C. Hamiltoniæ	7	63. Trematospira camura	2
18. Athyris spiriferoides	8	64. T? Deweyi	8
19. A. subtilita	12	65. T? hirsuta	7
20. A? congesta	7	66. T. multistriata	4
21. A. ambigua	1	67. T. perforata	1
22. A. trinuclea	8	68. Eumetria Mormoni	11
23. A. Royssi	1	69. E. Verneuiliana	6
24. A. subquadrata	5	70. E. vera	8
25. A. concentrica	1	71. Atrypa reticularis	12
26. A. sp?	1	72. A. marginalis	1
27. A? Junia	3	73. A. spinosa	1
28. A. Angelica	1	74. A? bisulcata	4
29. A. sublamellosa	2	75. Zygospira modesta	5
30. A. vittata	16	76. Z. erratica	2
31. Merista sp. n	4	77. Z. recurvirostra	16
32. M? scalprum	1	78. Z. Kentuckiensis	4
33. Meristella nasuta	2	79. Z. Anticostiensis	1
34. M? cylindrica	1	80. Cœlospira? Camilla	4
35. M? nitida	14	81. C. concava	5
36. M? naviformis	3	82. C. acutiplicata	2
37. M. bella	3	83. C? imbricata	6
38. M. Haskinsi	1	84. Leptocœlia fimbriata	1
39. M. Doris?	12	85. Koninckina Leonhardi	4
40. M. Barrisi	1	86. Rhynchonella Indianensis	1
41. M. laevis	2	87. R. neglecta	2
42. M. lenticularis	1	88. R? cuneata	2
43. M? intermedia	2	89. Anastrophia internascens	1
44. Meristina Maria	15	90. Camarophoria Schlotheimi	1
45. M. rectirostra	4	91. C? eucharis	3
46. Pentagonia unisulcata	4	92. C. calcifera	1

93. Triplesia lateralis	4	99. Dielasma bovidens	2
94. Rensselæria mutabilis	8	100. Vitulina pustulosa	3
95. R. Suessana	8	101. Tropidoleptus carinatus	1
96. Terebratula sp?	4	102. Eichwaldia reticulata	2
97. T? Calvini	1	Total	468
98. Cryptonella planirostra	3		

A LIST OF THE GENERA OF THE PALAEOZIC BRACHIOPODA,

giving citations to the printed portion of the Paleontology of New York, volume VIII, part i, to the manuscript determinations for parts i and ii, and indicating the genera to be discussed in the remainder of the work.

(Terms regarded as synonyms are in *italics* and unnumbered.)

PART I: VOLUME VIII.

I.

PAGE.

Brachiopoda Inarticulata ... 1, 2
1. Lingula, Bruguiere, 1789 ... 2–18
2. Dignomia, Hall, 1871 ... 14
3. Glossina, Phillips, 1848 ... 15
4. Lingulops, Hall, 1871 ... 18–24
5. Lingulasma, Ulrich, 1889 ... 24–28
6. Lahkmina, Œhlert, 1887 ... 28–30
Trimerellidae ... 30–33
7. Trimerella, Billings, 1862 ... 33–36
8. Dinobolus, Hall, 1871 ... 36–40
Obolellina, Billings, 1871.
9. Monomerella, Billings, 1871 ... 40–44
10. Rhinobolus, Hall, 1871 ... 44–46
Observations on the Development and Function of the Platform in the Inarticulate Brachiopoda ... 46–55
11. Lingulella, Salter, 1866 ... 55–59
12. Lingulepis, Hall, 1863 ... 59–62
13. Barroisella, gen. nov ... 63–64
14. Tomasina, gen. nov ... 65
15. Obolella, Billings, 1861 ... 66–73
Dicellomus, Hall, 1871.
16. Leptobolus, Hall, 1871 ... 73–75
17. Elkania, Ford, 1886 ... 75–78
18. Paterula, Barrande, 1879 ... 78, 79
19. Obolus, Eichwald, 1829 ... 80, 81
20. Aulonotreta, Kutorga, 1848 ... 82
21. Schmidtia, Volborth, 1869 ... 83

PAGE.
22. Monobolina, Salter, 1865 ..... 83, 84
23. Neobolus, Waagen, 1885 84
24. Spondylobolus, McCoy, 1853 85
25. Mickwitzia, Schmidt, 1888 ..... 86, 87
26. Schizobolus, Ulrich, 1886 87-90
27. Discinolepis, Waagen, 1885 90
28. Kutorgina, Billings, 1861 90-94
29. Schizopholis, Waagen, 1885 ..... 94, 95
30. Volborthia, Von Moller, 1873 ..... 95, 96
31. Iphidea, Billings, 1872 ..... 97, 98
32. Acrothele, Linnarsson, 1876 98-101
33. Acrotreta, Kutorga, 1848 101-104
34. Conotreta, Walcott, 1889 ..... 104, 105
35. Discinopsis (Matthew) gen. nov 105, 106
36. Linnarssonia, Walcott, 1886 107-109
37. Mesotreta, Kutorga, 1848 109
38. Siphonotreta, de Verneuil, 1845 110-113
39. Schizambon, Walcott, 1884 113-117
40. Keyserlingia, Pander, 1861 117-119
41. Helmersenia, Pander, 1861 119
Discina, Lamark, 1819; Orbicula, Sowerby, 1822; 42. Orbiculoidea, d'Orbigny, 1847; 43. Schizotreta, Kutorga, 1848; Orbiculoidea, Davidson, 1856; Discinisca, Dall, 1871; 44. Lindstroemella, sub-gen. nov.; 45. Œhlertella, sub-gen. nov.; 46. Roemerella, sub-gen. nov.; Discina, of Authors 120-137
47. Trematis, Sharpe, 1847 138-142
Orbicella, d'Orbigny, 1847.
48. Schizocrania, Hall and Whitfield, 1875 142-144
49. Crania, Retzius, 1781 145-151
Choniopora, Schauroth, 1854.
Pseudocrania, McCoy, 1851 151
50. Palaeocrania, Eichwald, 1860 152
51. Craniella, Œhlert, 1888 153
52. Cardinocrania, Waagen, 1885 154
53. Pholidops, Hall, 1859 155-159
Craniops, Hall, 1859.
Note on Orbiculoidea 160
Conclusion 161-170

SUPPLEMENT TO THE BRACHIOPODA INARTICULATA:

Descriptions of New Species referred to in the preceding pages or on the accompanying plates.

PAGE.
(1) Lingula compta 171
(2) L. scutella 171, 172
(3) L. flabellula 172
(4) L. paracletus 172

PAGE.
(5) L. taeniola (nom. nov.) 173
(6) L. lingulata 173
(7) Lingulops Granti.. 173
(8) Monomerella Greenii 174
(9) M. Kingi 174, 175
(10) M. Ortoni 175
(11) M. Egani 175, 176
(12) Rhinobolus Davidsoni 176
(13) Siphonotreta (?) Minnesotensis 177
(14) Orbiculoidea (Schizotreta) ovalis 177
(15) Orbiculoidea numulus 178
(16) O. Herzeri 178
(17) Lindstroemella aspidium 178, 179
(18) Schizocrania Schucherti 179
(19) Schizocrania (?) Helderbergia 179, 180
(20) Crania agaricina 180
(21) C. pulchella 180
(22) C. granosa 180
(23) C. favincola 181
(24) Craniella Ulrichi 181
(25) Pholidops calceola 182
(26) P. patina 182
Supplementary Note on the Genus Kutorgina 183

II.

Brachiopoda Articulata 185, 186
Orthis, Dalman, 1828 186–192
54. Orthis, Dalman, as restricted 192–194
Orthambonites, Pander, 1830.
55. Plectorthis (nom. propos.) 194, 195
56. Dinorthis (nom. propos.) 195, 196
57. Plaesiomys (nom. propos.) 196, 197
58. Hebertella (nom. propos.) 198, 199
59. Orthostrophia, Hall, 1883 ..... 199, 200
60. Platystrophia, King, 1850 200–202
61. Heterorthis (nom. propos.) 202, 203
62. Bilobites, Linné, 1775 ..... 204, 205
Dicoelosia, King, 1850.
63. Dalmanella (nom. propos.) 205–207
64. Rhipidomella, Œhlert, 1890 208–211
65. Schizophoria, King, 1850 211–213
66. Orthotichia (nom. propos.) 213, 214
67. Enteletes, Fischer de Waldheim, 1830 214–217
Syntrielasma, Meek, 1865.
Observations on Orthis 217–220
List of Genera and Species 220–226
Supplementary Note on Orthis 227–229

PAGE.

68. Billingsella, gen. nov 230, 231
69. Protorthis, gen. nov 231–232
70. Clitambonites, Pander, 1830 238–239
Orthisina, d'Orbigny, 1847.
71. Hemipronites, Pander, 1830.
72. Gonambonites, Pander, 1840.
73. Polytoechia, sub-gen. nov 239, 240
74. Scenidium, Hall, 1860 241–248
Mystrophora, Kayser, 1871.
75. Orthidium, gen. nov 244
76. Strophomena, Rafinesque (de Blainville), 1825 245–252
77. Orthothetes, Fischer de Waldheim, 1830 253–257
78. Hipparionyx, Vanuxem, 1842 257–259
79. Kayserella, gen. nov 259, 260
80. Derbya, Waagen, 1884 260–263
81. Meekella, White and St. John, 1868 264–266
82. Streptorhynchus, King, 1850 ..... 267, 268
83. Triplecia, Hall, 1858 269–271
Dicraniscus, Meek, 1872.
84. Mimulus, Barrande, 1879 ..... 272, 273
84. Streptis, Davidson, 1881 274
86. Leptaena, Dalman, 1828 276–280
Leptagonia, McCoy, 1844.
87. Rafinesquina, gen. nov 281–283
88. Strophеodonta, Hall, 1852 284–289
89. Pholidostrophia, sub-gen. nov 287
90. Leptostrophia, sub-gen. nov 287, 288
91. Brachyprion, Shaler, 1865 288
92. Douvillina, Œhlert, 1887 ..... 288, 289
93. Strophonella, Hall, 1879 ..... galley proof.
94. Amphistrophia, sub-gen, nov ..... do
95. Leptella, gen. nov ..... do
96. Leptænulopsis, Haupt, 1878 (??) ..... do
97. Plectambonites, Pander, 1830 ..... do
98. Christiania, gen. nov ..... do
99. Leptænisca, Beecher, 1890 ..... do
100. Davidsonia, Bouchard, 1849 ..... do
101. Chonetes, Fischer de Waldheim, 1837 ..... do
102. Anoplia, sub-gen. nov ..... do
103. Chonetina, Krotow, 1888 ..... do
104. Chonostrophia, gen. nov ..... do
105. Chonopectus, gen. nov ..... do
106. Chonetella, Waagen, 1884 ..... do
107. Strophalosia, King, 1844 ..... do
Leptœnalosia, King, 1845.
Orthrothrix, Geinitz, 1847.
108. Daviesiella, Waagen, 1884 ..... do
109. Aulosteges, von Helmerson, 1847 ..... do

110. Productus, Sowerby, 1812 ..... not printed.
111. Productella, Hall, 1867 ..... do
112. Marginifera, Waagen, 1884 ..... do
113. Proboscidella, Œhlert, 1887 ..... do
114. Etheridgina, Œhlert, 1887 ..... do

VOLUME VIII; PART II.

115. Spirifer, Sowerby, 1815	In manuscript subject to revision.	
116. Delthyris, Dalman, 1828	do	do
Trigonotreta, Koenig, 1825	do	do
Choristites, Fischer de Waldheim, 1825	do	do
Brachythyris, McCoy, 1844	do	do
Fusella, McCoy, 1844	do	do
117. Martinia, McCoy, 1844	do	do
118. Reticularia, McCoy, 1844	do	do
119. Martiniopsis, Waagen, 1883	do	do
120. Cyrtia, Dalman, 1828	do	do
121. Spiriferina, d'Orbigny, 1847	do	do
122. Syringothyris, Winchell, 1863	do	do
123. Cyrtina, Davidson, 1858	do	do
124. Amboccelia, Hall, 1860	do	do
125. Metaplasia, nom. propos	do	do
126. Meristina, Hall, 1867	do	do
Whitfieldia, Davidson, 1882	do	do
127. Whitfieldella, nom. propos	do	do
128. Hyatella, nom. propos	do	do
129. Merista, Suess, 1851	do	do
Camarium, Hall, 1859	do	do
130. Dicamara, nom. propos	do	do
131. Meristella, Hall, 1859	do	do
132. Charionella, Billings, 1861	do	do
133. Camarospira, nom. propos	do	do
134. Pentagonia, Cozzens, 1846	do	do
Goniocœlia, Hall, 1861	do	do
135. Athyris, McCoy, 1844	do	do
Spirigera, d'Orbigny, 1847	do	do
Euthyris, Quenstedt, 1871	do	do
136. Actinoconchus, McCoy, 1844	do	do
137. Cliothyris, King, 1850	do	do
138. Seminula, McCoy, 1844	do	do
139. Spirigerella, Waagen, 1883	do	do
141. Kayseria, Davidson, 1882	do	do
142. Bifida, Davidson, 1882	do	do
143. Nucleospira, Hall, 1859	do	do
144. Eumetria, Hall, 1864	do	do

145. Acambona, White, 1862	In manuscript subject to revision.	
146. Hustedia	do	do
147. Retzia, King, 1850	do	do
148. Trematospira, Hall, 1857	do	do
149. Parazyga, nom. propos	do	do
150. Rhynchospira, Hall, 1859	do	do
151. Homœospira, nom. propos	do	do
152. Ptychospira, nom. propos	do	do
153. Uncinella, Waagen, 1883	do	do
154. Uncites, Defrance, 1825	do	do
155. Hindella, Davidson, 1852	do	do
156. Dayia, Davidson, 1881	do	do
157. Cyclospira, nom. propos	do	do
158. Atrypa, Dalman, 1828	do	do
Spirigerina, d'Orbigny, 1847	do	do
159. Gruenewaldtia, Tschernyschew, 1885	do	do
160. Karpinskia, Tschernyschew, 1885	do	do
161. Atrypina, nom. propos	do	do
162. Zygospira, Hall, 1862	do	do
Orthonomœa, Hall, 1858	do	do
Anazyga, Davidson, 1882	do	do
163. Catazyga, nom. propos	do	do
164. Glassia, Davidson, 1882	do	do
165. Anoplotheca, Sandberger, 1856	do	do
166. Leptocœlia, Hall, 1857	do	do
167. Cœlospira, Hall, 1863	do	do
168. Rhynchonella, Fischer de Waldheim, 1809	Discussions not yet prepared.	
169. Cyclothyris, McCoy, 1844	do	do
170. Hypothyris, Phillips, 1841	do	do
171. Wilsonia, Quenstedt, 1871	do	do
172. Uncinulus, Bayle, 1878	do	do
173. Terebratuloidea, Waagen, 1883	do	do
174. Rhynchotrema, Hall, 1860	do	do
175. Rhynchopora, King, 1856	do	do
176. Rhynchoporina, Œhlert, 1887	do	do
177. Eatonia, Hall, 1857	do	do
178. Stenocisma, Conrad, 1839	do	do
179. Rhynchotreta, Hall, 1879	do	do
180. Liorhynchus, Hall, 1860	do	do
181. Pentamerus, Sowerby, 1813	do	do
182. Zdimir, Barrande, 1881	do	do
183. Sieberella, Œhlert, 1887	do	do
184. Conchidium, Linné, 1760	do	do
185. Gypidium, Dalman, 1828	do	do
186. Gypidula, Hall, 1867	do	do
187. Pentamerella, Hall, 1867	do	do
188. Camarophoria, King, 1846	do	do
189. Barrandella nom. propos	do	do

190. Lycophoria, Lahusen, 1885	Discussions not yet prepared.	
191. Anastrophia, Hall, 1867	do	do
192. Brachymerus, Shaler, 1865	do	do
193. Camarella, Billings, 1859	do	do
194. Syntrophia, gen. nov	do	do
195. Stricklandinia, Billings, 1863	do	do
196. Amphigenia, Hall, 1867	do	do
197. Clorinda, Barrande, 1879	do	do
198. Branconia, Gagel, 1890	do	do
199. Porambonites, Pander, 1830	do	do
200. Isorhynchus, King, 1850	do	do
201. Eichwaldia, Billings, 1868	do	do
202. Dictyonella, Hall, 1867	do	do
203. Aulacorhynchus, Dittmar, 1872	do	do
204. Isogramma, Meek and Worthen, 1873	do	do
205. Lyttonia, Waagen, 1883	do	do
206. Oldhamina, Waagen, 1883	do	do
207. Stringocephalus, Defrance, 1827	do	do
208. Terebratula, Muller, 1776	do	do
209. Dielasma, King, 1850	do	do
210. Epithyris, King, 1850	do	do
211. Waldheimia, King, 1850	do	do
212. Cryptacanthia, White and St. John, 1868	do	do
213. Eudesia, King, 1850	do	do
214. Hemiptychina, Waagen, 1883	do	do
215. Centronella, Billings, 1859	do	do
216. Cryptonella, Hall, 1861	do	do
217. Rensselaeria, Hall, 1859	do	do
218. Newberria, Hall, 1891	do	do
219. Meganteris, Suess, 1856—(Megalanteris)	do	do
220. Notothyris, Waagen, 1882	do	do
221. Richthofenia, Kayser, 1883	do	do

Additions to the Palæontological Collections.

November, 1890 — September, 1891.

BY DONATION.

	No. specimens.
T. Rupert Jones, London, Eng.:	
Primitiæ and Ulrichiæ. Bala beds. Welshpool, Montgomeryshire	4
Bernix Tatii, Jones. Yoredale series. Walwick grange, Northumberland	2
Cypris punctata. Upper Purbeckian, Meups Bay	1
C. leguminella. Upper Cypris shales, Meups Bay	1
C. Purbeckensis. Lower Purbeckian, Ridgeway Hill	2
C. Purbeckensis. Lower Purbeckian, Worbarrow Bay	2
G. H. Mahan, Norwich, N. Y.:	
Hamilton fossils	5
G. Lindström, Stockholm, Sweden:	
Goniophyllum pyramidale, Hisinger. Gotland	7
The Assistant Palæontologist:	
Fossils from a pleistocene shell marl, Canandaigua Lake, N. Y.	
Helix albolabris, Say	15
H. thyroides, Say	15
H. Sayi, Binney	1
H. alternata, Say	13
H. tridentata, Say	20
H. fuliginosa, Griffith	2
H. appressa, Say	4
H. palliata, Say	1
H. perspectiva, Say	3
H. striatella, Anthony	2
H. labyrinthica, Say	11
H. monodon, var. fraterna	4
Hyalina lineata, Say	3

	No. specimens.
Hyalina arborea, Say	14
Hy. viridula, Say	4
Hy. fulva, Say	3
Zonites suppressa, Say	8
Cionella subcylindrica, Linné	2
Succinea ovalis, Gould	4
Pupa contracta, Say	2
P. armifera, Say	1
P. curvidens, Gould	2
Carychium exiguum, Say	2

(Identifications corrected and verified by Mr. W. B. Marshall.)

Emmett Brown, Belfast, N. Y.:

Retzia Eugenia, Bill. Hamilton group, York, N. Y	7
Nucleocrinus sp.? Hamilton group, York, N. Y	1

Dr. E. Holzapfel, Aachen, Germany:

Bifida lepida. Middle Devonian, Pelm	10

W. R. Billings, Ottawa, Canada:

Atrypa bisulcata. Trenton group, Ottawa	7

Charles Schuchert, Albany, N. Y.:

Palæaster? sp. Clinton group, Clinton, N. Y.	1

W. B. Marshall, Albany, N. Y.:

Spirifer arrectus. Oriskany sandstone (boulder), New Baltimore, N. Y.	2
Platyceras sp.? Lower Helderberg limestone, New Baltimore, N. Y.	1

C. F. Goodwin, Cleveland, Ohio:

Coal plant. Ashland, Pa.	1

Agnes Crane, Brighton, England:

Orthis hybrida. Wenlock, Benthall Edge, Shropshire	11
O. elegantula. Wenlock, Benthall Edge, Shropshire	9
Nucleospira pisum. Wenlock, Benthall Edge, Shropshire	3
Spirifer crispus. Wenlock, Benthall Edge, Shropshire	3
Glassia obovata. Wenlock, Benthall Edge, Shropshire	2
Atrypa reticularis. Wenlock, Benthall Edge, Shropshire	5
Porambonites? Lower Silurian, near St. Petersburg	3

	No. specimens.
Athyris ambigua. Carboniferous, Tyrone, Ireland	1
A. protea. Carboniferous, Caucasus	1
A. planosulcata. Carboniferous, Welton, Staffordshire.	1
Athyris? sp? Locality?	1
Terebratula sacculus. Carboniferous, Welton, Staffordshire.	4
The Assistant Palæontologist:	
Lepadocrinus sp? Lower Pentamerus limestone, Coeymans, N. Y.	1
Spirifer Vanuxemi. Tentaculite limestone, Coeymans, N. Y.	1
Leptæna rhomboidalis. Corniferous limestone, Canandaigua, N. Y.	1
Orthoceras sp. Chemung group, Jasper, N. Y.	1
Modiomorpha. Chemung group, Jasper, N. Y.	2
Total	244

BY EXCHANGE.

Dr. D. F. Lincoln, Geneva, N. Y.:	
Centronella impressa. Hamilton group, Bellona, N. Y.	6
Spirifer asper. Hamilton group, Slate Rock Falls, Geneva, N. Y.	1
S. granuliferus. Hamilton group, Slate Rock Falls, Geneva, N. Y.	1
Pharetrella tenebrosa. Marcellus shales, Slate Rock Falls, Geneva, N. Y.	1
Dinicthys Lincolni, Claypole, 1893 (type), Marcellus shales, Slate Rock Falls, Geneva, N. Y	1
Orthis Vanuxemi. Hamilton group, Slate Rock Falls, Geneva, N. Y.	1
Lingula sp? Corniferous limestone, near Geneva	1
A. L. Arey, Rochester, N. Y.:	
Meristina nitida. Clinton group, Rochester	35
Atrypa reticularis. Clinton group, Rochester	1
Pentamerus sp. nov. Clinton group, Rochester	1
Rhynchonella sp. Clinton group, Rochester	2
G. L. Houser, Iowa City, Iowa:	
Stromatopora. Devonian, Iowa City, Ia	2
Diphyphyllum. Devonian, Solon, Ia	1
Megistocrinus Farnsworthi. Devonian, Solon, Ia	5

	No. specimens.
Orthis Iowensis. Devonian, Iowa City, Ia	9
Atrypa reticularis. Devonian, Buffalo, Ia	5
Atrypa reticularis. Devonian, Solon, Ia	4
A. aspera. Devonian, Solon, Ia	16
Athyris vittata. Devonian, Buffalo, Ia	7
Athyris vittata. Devonian, Iowa City, Ia	14
Spirifer Parryanus. Devonian, Buffalo, Ia	3
Spirifer Parryanus. Devonian, Montpelier, Ia	8
S. pennatus. Devonian, Solon, Ia	6
Pentamerus coms. Devonian, Solon, Ia	3
Rhynchonella alta. Devonian, Solon, Ia	18
Terebratula Iowensis. Devonian, Robert's Ferry, Ia	1
Straparollus cyclostoma. Devonian, Coralville, Ia	5

Dr. Th. Tschernyschew, St. Petersburg (not before reported):

Pentamerus Bashkiricus. Devonian, Russian Urals	1
P. galeatus. Devonian, Russian Urals	3
Rhynchonella livonica. Devonian, Russian Urals	2
R. Meyendorfi, Devonian, Russian Urals	1
R. procuboides. Devonian, Russian Urals	2
R. cuboides. Devonian, Russian Urals	2
Spirifer bifidus. Devonian, Russian Urals	2
S. pachyrhynchus. Devonian, Russian Urals	2
S. Jeremejewi. Devonian, Russian Urals	3
S. elegans. Devonian, Russian Urals	2
S. Anossofi. Devonian, Russian Urals	5
Atrypa reticularis. Devonian, Russian Urals	2
A. aspera. Devonian, Russian Urals	4
A. Alinensis. Devonian, Russian Urals	2
Cyrtia Murchisoni. Devonian, Russian Urals	2
Orthis Ivanovi. Devonian, Russian Urals	1
O. striatula. Devonian, Russian Urals	1
Camarophoria subreniformis. Devonian, Russian Urals	1
Chonetes plebeia. Devonian, Russian Urals	1

Charles Schuchert, Albany, N. Y.:

Specimens from the Marcellus shales and limestone at Chapinville, Mertensia and Canandaigua, N. Y.; consisting principally of cephalopoda and plants	200
Posidonomya Becheri. Culm. Bredelar, Germany	1
P. tuberculata. Culm. Lautenthal, Germany	2

	No. specimens.
Goniatites crenistriatus. Culm. Winterberg, Germany.....	2
Goniatites crenistriatus. Culm. Schalke, Germany	2
G. coronula. Culm. Clausthal, Germany.....	1
Plants. Coal measures. Pomeroy, Ohio, (slabs).....	2
Platycrinus granosus. Coal measures, Tournai, Belgium....	2
Ceratites nodosus. Muschelkalk. Göttingen, Germany.....	1
Monotis Alberti. Muschelkalk. Rüdersdorf, Germany.....	1
Rhynchoteuthis. Muschelkalk. Berklingen, Germany.....	1
Tæniodon Ewaldi. Rhætic. Elliehausen, Germany	2
Gresslya abducta. Jura. Dohnsen, Germany.....	5
Perna isognomoides. Jura. Dohnsen, Germany.....	1
Ammonites Gervillei. Jura. Dohnsen, Germany	8
A. polyplocus. Jura. Fichtelgebirge, Germany....	1
Pholadomya Murchisoniana. Jura. Ollerhausen, Germany..	1
P. acuticosta. Kimmeridge, Holtzen, Germany....	3
Pecten. Kimmeridge, Holtzen, Germany.....	1
Cyprina Brongniarti. Kimmeridge, Holtzen, Germany.....	4
Cercomya excentrica. Kimmeridge, Holtzen, Germany.....	1
Exogyra virgula. Kimmeridge, Holtzen, Germany.....	40
Fish tooth. Kimmeridge, Holtzen, Germany.....	1
Exogyra arietina. Cretaceous. Mountain City, Texas.....	11
Catopygus fenestratus. Cretaceous, Ciply.....	2
Sponge spicules. Cretaceous. Vorwohle, Germany.....	1
Ostrea gigantea. Tertiary. Morro, Cal.....	2
O. Idrianensis. Tertiary. Morro, Cal	4
Pecten discus. Tertiary. Morro, Cal	1
Mytilus Inezensis. Tertiary. Morro, Cal.....	1
Pecten sp. Tertiary. Morro, Cal.....	2
P. Veatchi. Tertiary. Morro, Cal.....	1
Melania. Tertiary. Paris, France.....	1
Cypræa coccinella. Tertiary, Palermo, Italy.....	1
Fusus multisulcatus. Tertiary. Basle.....	1
Planorbis euomphalus. Tertiary. Headon Hill, England....	2
Limnea longiscata. Tertiary. Headon Hill, England.....	2
Pectunculus Philipi. Post-tertiary, Hitzaeker, Germany.....	2
Clausilia similies. Post-tertiary. Zierenberg, Germany.....	4
Bulimus montanus. Post-tertiary. Zierenberg, Germany ..	3
Planorbis carinatus. Post-tertiary. Saxe-Weimar, Germany.	1
Limnæa palustris. Post-tertiary. Saxe-Weimar, Germany..	9
Helix incarnata. Post-tertiary. Zierenberg, Germany.....	5

	No. specimens.
Reptilian coprolites. Post-tertiary. Georgetown, S. Car....	6
Elephant tooth. Post-tertiary. Charleston, S. Car.....	1
Emmett Brown. Belfast, N. Y.:	
Retzia Eugenia, Bill. Hamilton group. York, N. Y.....	6
Taxocrinus. Chemung group. Belfast.....	1
Rhynchonella cf. pugnus. Chemung group. Belfast.....	2
Terebratula cf. navicella. Chemung group. Belfast	10
T. sp. Chemung group. Belfast.....	4
Centronella Julia ?. Chemung group. Belfast.....	1
Athyris Angelica. Chemung group. Belfast.....	5
E. A. Parks, Clarence, N. Y.:	
Dalmanites aspectans. Corniferous limestone. Clarence....	1
Atrypa congesta. Clinton group (drift)	1
E. H. Raymour, Kansas City, Mo.:	
Proetus crassimarginatus. Corniferous limestone. Waverly, Ind.....	28
P. cf. macrocephalus. Corniferous limestone. Waverly, Ind.	9
Brachiopods (various species), Corniferous limestone. Waverly, Ind.....	42
Gastropods. Corniferous limestone. Waverly, Ind.....	7
Aviculopecten sp. Corniferous limestone. Waverly, Ind....	2
F. B. Loomis, Spencerport, N. Y.:	
Brachiopods. Clinton shale. Buell avenue, Rochester.....	200
Dr. Friedrich Schmidt, Reval. Russia:	
Eurypterus Fischeri. Rootsikull, Œsel	2
Pterygotus Osiliensis. Rootsikull, Œsel	2
Porambonites gigas. Lyckholm, Estland	1
Leptocœlia Deshayési. Estland	1
Atrypa imbricata. Estland.....	1
Obolus Apollinis. Tegelecht	1
Onchus Murchisoni. Œsel.....	1
Pentamerus borealis. Weissenfeld	3
Volborthella tenuis. Reval.....	1
Thyestes verrucosus. Rootsikull, Œsel.....	1
Pachylepis. Œsel.....	1
Tentaculites curvatus Beyrichia Wilckensiana } Œsel	1

	No. specimens
Olenellus Mickwitzi. Estland	1
Platyschisma helicites. Œsel	2
D. G. Anderson, Keokuk. Iowa:	
Brachiopods (various species). Keokuk limestone. Keokuk	60
L. A. Cox:	
Brachiopods (various species), Keokuk limestone. Keokuk	73
Total	1,002

BY COLLECTION.

Jacob Van Deloo, November, 1890:

Fossils from the Chazy limestone. Keeseville. N. Y. (museum ticket, 1,113) 244

D. D. Luther, May–July, 1891:

Fossils from the Genesee and upper Hamilton shales at the Livonia salt shaft, 19 boxes, 1 barrel.

Fossils, September, 1891, from the middle Hamilton shales, 9 boxes.

Martin Sheehy and Jacob Van Deloo, September, 1891:

Fossils from the Oriskany fauna, near Hudson, N. Y., 9 boxes (approximately 700 specimens).

SUMMARY OF RECEIPTS.

By donation	244
By exchange	1,002
By collection (approximately)	2,600
Total	3,846

During the past year two school collections have been selected, labeled and sent out as follows: Parker Union School of Clarence, New York, containing 170 species and 241 examples. St. Lawrence University, Canton, St. Lawrence county. New York, 140 species and 217 examples.

I report herewith a communication from Prof. J. M. Clarke, Assistant Palæontologist, together with a List of Original and Illustrated specimens in the Palæontological collections. Part I, CRUSTACEA. It is intended to continue this work until the

list shall be completed in all classes of fossils embraced in the Palæontology of New York. The preparation of such a list of each class of fossils (to be illustrated) has been a long time contemplated by the writer and it is very gratifying to be able to present at this time the first installment of the work.

The requirement to present the Annual Report in October has necessarily left unfinished several communications which would have been completed during the coming months, had the presentation of the report been delayed till the end of the year, which has been the custom until the present occasion.

Very respectfully,

Your obedient servant.

JAMES HALL,
State Geologist.

ALBANY, *October*, 1891.

CATALOGUE

OF THE

Collection of Geological and Palæontological Specimens, Donated by the Albany Institute to the State Museum.

[Prepared by Professor John M. Clarke and communicated to Professor James Hall, State Geologist, December 1, 1891.]

CATALOGUE.

The collection of the Albany Institute was received at the State Museum in the month of August, and formally donated to the institution on the 6th of October, 1891.* When the fossils came into my hands I found them in bad condition. Such labels as existed had been gathered into piles and boxes by themselves, with the exception of the few instances in which they had been glued to the specimens. The majority of the specimens, however, bore a numeral ticket, which had been copied upon the separated labels, and by means of this arrangement the matching of the few labels with their specimens was not difficult. Fortunately, these labeled specimens constitute the most important part of the collection; they are mostly Trilobites, and embrace a number of the original types used by Dr. Jacob Green in his "Monograph of Trilobites of North America," with much other interesting material of the same class, and in addition are several type-specimens of Cephalopods from the Black River limestone, described by yourself in volume I of the Palæontology of New York.

Of this series of labeled specimens a few are evidently missing, but perhaps not as many as, under the circumstances, one might expect. It appears from the labels on the rest of the collection that the specimens were divided into groups, each with its own form of numerical ticket. It is understood that there was a manuscript register or catalogue of these specimens, but it was not found among the documents pertaining to the collection nor delivered with it, and subsequent careful search among the archives of the Institute has failed to discover it. The want of this catalogue has naturally added greatly to the task of identifying the specimens. On account of the historical value of this collection I have taken much pains to locate such material as proves

*The extensive collection of minerals donated to the State Museum at the same time, together with other collections of natural history, have not come under the cognizance or control of the State Geologist, and no account of them can be given in this connection.

to be a genuine contribution to the State Museum. By far the greater number of specimens are from familiar outcrops of the New York series of formations, and their source can be approximately indicated without much danger of error. For us the value of this collection lies almost wholly in its New York palæozoic. fossils; the few mesozoic and tertiary specimens being from scattered and uncertain American and European localities.

ALBANY INSTITUTE COLLECTION. FOSSILS.

I. A small series labeled by Prof. Amos Eaton, but without localities

"1 Gorgonia ripisteria Nobis" = = *Polypora celsipora*, Hall.

In a fragment of decomposed Corniferous chert, apparently from western New York.

The original description of this species is as follows:

"*G. ripisteria*, very branching and net-form, spread out like a fan; branchlets subcompressed, coalescent, minutely striated: bark granulose. Found at Bethlehem in corniferous limerock; 1¼ inches long." (Geological Text Book. 2nd. Ed., p. 43, pl. 4, fig. 47, 1832.)

"2 Coscinopora macropora"

From the Lower Helderberg shaly limestone.

"*C. macropora* (large-mouthed net-stone) patella-form, pores orbicular, interstices with greater or less punctures.

"In second graywacke on Becraft Mt., near Hudson. Very irregular in external form." (*Op. cit.* p. 43, pl. 5, figs. 59, 60.)

3 and 4 missing.

"5 Turbinolia mitrata" = = a worn specimen of *Streptelasma corniculum*, Hall. Trenton limestone.

Original description:

"*T. mitrata* (mitred cone, smooth horn), subcompressed on the sides; apex incurved: lamellæ thickish, sub-connate and papillose at the surface, unequal, somewhat toothed, forming an ovate, stellate disk. My specimens average an inch in length. Found at Glens Falls." (*Op. cit.*, p. 39, pl. 3, figs. 32, 33.)

6, 7, 8 missing.

"9 Cyathophyllum ceratites." (*Cystiphyllum*) Corniferous limestone.

"10 Lithodendron dichotomum" = = *Bythotrephis gracilis*, Hall. Trenton limestone.

Original description:

"*L. dichotomum* (cylindrical stone tree). Cespetose, erect. Subflexuose; branches dichotomous, densely striate; little stars excavated orbicularly. Very common at Glens Falls, lying between the layers of

the limerock." (*Op. cit.*, p. 39, pl. 4, fig. 43.) The description and figures represent a true coral, which, if correct, do not apply to any of the known species from the Trenton limestone.

11 missing.

"12 Astrea stylophora"= *Michelinia stylopora* Eaton (sp.). Hamilton group.

Original description:

"*A. stylopora* (star stone). Hemispherical; little stars angle-tubular, approximating and contiguous, margin glabrous, lamellæ distant; the center of the column or star extended a little. Common on the south bank of Lake Erie; about one inch in diameter." (*Op. cit.*, p. 40, pl. 4, fig. 48.)

"13 Columnaria sulcata"= *Columnaria alveolata* (Goldfuss), Hall, Black River limestone.

Original description:

"*C. sulcata* (furrowed corals) tubes generally parallel and straight, sometimes a little curved; furrowed longitudinally and substriate; lamellæ of the stars radiating from the center, and the marginal ones alternating. Very abundant in transition limerock at Glens Falls, where it is generally dark brown. We find some there whose prismatic columns are six inches long." (*Op. cit.*, p. 41, pl. 5, fig. 51.)

"14 Columnaria alveolata"= *Favosites Helderbergiæ*, Hall, Lower Helderberg (Shaly limestone).

This is apparently Prof. Eaton's identification of Goldfuss' species. His description is:

"*C. alveolata* (coral cakes). Hemispherical (often concave, convex and sometimes flat) tubes unequal in length, striated longitudinally, and radiating from the base; those lamellæ of the little stars are rather remote which radiate from the center, the marginal ones alternating. Very abundant over the Coral cone on the Helderberg. They are from three inches in diameter to ten." (*Op. cit.*, p. 40, pl. 4, figs. 44, 45.)

"15 Sarcinula macrophthalma, var. prismatica." Label only.

16, 17, 18, 19 missing.

"20 Terebratula Perovalis." Label only.

21 missing.

"22 Terebratula spiriferoides, Nobis"= *Athyris spiriferoides*, Eaton (sp.). Hamilton group. (*Op. cit.*, p. 46.)

"23 Terebratula dimidiata" (*Pentamerella arata*, Hall). Corniferous limestone.

"24 Spirifer alternatus." Label only.

"25 Resembles Spirifer Walcottii. Probably near = *Spirifer macropleura*, Conrad." Lower Helderberg (Shaly limstone).

26 missing.

"27 A pentacrinite being the Encrinus dicyclus"=Crinoidal disks from the Hamilton or Chemung group.

"28. Encrinus transversus" = *Phytopsis tubulosa*, Hall.

Birdseye limestone.

Original description:

"*E. transversus* (birdseye pins) rings low or confluent, so that the column appears nearly or quite smooth; perforates strata transversely. Found in the lowest and most compact layers of metalliferous limerock. It is called Encrynal by Conybeare and Birdseye marble by stonecutters." (*Op. cit.*, p. 36.)

"29. Encrinus interruptus." Corniferous limestone.

"30. Productus depressus in 2d Graywacke" = *Leptæna rhomboidalis*, Wilckens. Lower Helderberg (Shaly limestone).

"31. Orthocera circularis" = *Orthoceras* sp.? probably from the Corniferous limestone. (*Op. cit.*, p. 29, pl. 3, fig. 27.)

"32 Cancer triloboides Nobis" = *Brongniartia carcinodea*, Eaton, 1832 = *Triarthrus Becki*, Green, 1832. Utica slate.

"33. Conularia quadrisulcata" = *Conocardium trigonale*, Conrad.

"Cyathophyllum ceratites" = *Zaphrentis* sp.?

"Gorgonia ripisteria" = = *Polypora celsipora*, Hall (?).

II. The collection of TRILOBITES had been carefully labeled by the late Dr. T. R. Beck, and though these labels were all displaced, the numbering on both labels and specimens has facilitated their replacement. This collection is composed of some small lots not included in the serial numbering of the general collection, and a few embraced the initiatory portion of the latter.

1. Plaster-of-paris models of Trilobites described by Dr. Jacob Green in his "Monograph of the Trilobites of North America," 1832.

No. 1, Calymene Blumenbachii, Brongniart, Trenton Falls.
No. 2, C. callicephala, Green, "Hampshire, Virginia."
No. 5, C. platys, Green, Helderberg (3 specimens).
No. 6, C. microps, Green, near Ripley, Ohio. (?)
No. 9, C. macrophthalma, Brongniart, Leheighton, Pa.
No. 10, C. Bufo, Green, New Jersey.
No. 17, Asaphus caudatus, Brünnich, Ripley, Ohio.
No. 28, Cryptolithus tesselatus, Green, Champlain canal.
No. 31, Dipleura DeKayi, Green, Northumberland, Pa. (?)

No. 32, Trimerus delphinocephalus, Green, Williamsville, N. Y. (?)
No. 35, Nuttainia sparsa, Eaton, Coeymans, N. Y.
Also model of the original of Isotelus magnus, DeKay, Trenton Falls, N. Y.

2. *The James Eights collection:*
1, Cryptolithus tesselatus, Green, Glens Falls, N. Y.
2, Calymene bufo, Green, Helderberg.
3, Triarthrus Beckii, Green, 7 miles east of Little Falls, N. Y.
5, Asaphus (= *Dalmanites anchiops*, Green), Helderberg, N. Y.
6, Dalmanites anchiops, Green (without label).
8, Asaphus micrurus, Green (= *Dalmanites pleuroptyx*, Green) Helderberg, N. Y.
9, Dipleura DeKayi, Green, Black river, Jefferson county, N. Y. (?)
"The heads of two trilobites in the Dudley limestone," (= Phacops Downingiæ), Dudley, England.

3. *The G. W. Clinton collection:*
(a) Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Madison county, N. Y.
(b) "A Fragment of the Isotelus gigas" (Gov. Clinton's label), = Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Steuben county (?? probably Madison county) N. Y.
(c) Dipleura DeKayi, Green (specimen mentioned in Green's Monograph, p. 80), Cazenovia, N. Y.
(d) "Head of the Isotelus, Cazenovia, Madison county" (Gov. Clinton's label),= Dipleura DeKayi (specimen mentioned in Green's Monograph, p. 80).
(e) Dipleura DeKayi, Green, Steuben (?? probably Madison) county, N. Y.

4. *Small miscellaneous lot:*
"Petrified crab or cancer in 2d Greywacke," = *Triarthrus Becki*, 2 specimens.
Dalmanites anchiops (without label). Fragment.

5. *Trilobites of the General Collection.*
I, a, 1. Calymene anchiops, Green. ORIGINAL. Ulster county, N. Y. *John R. Bleecker, Don.*
I, a, 2. Missing.
I, a, 3. Calymene platys, Green. Corniferous limestone, Coeymans, N. Y.
I, a, 4. Calymene bufo, Green. (The head.) Corniferous limestone, Bethlehem, N. Y. *T. R. Beck, Don.*

I, a, 5. Calymene Blumenbachii. ("Dudley Trilobite.") Ohio. *T. R. Beck, Don.*

I, a, 6. Calymene bufo. var. rana, Green. ORIGINAL. Seneca, Ontario county, N. Y. *M. H. Webster, Don.*

I, a 7. Dipleura DeKayi, Green. (Specimen mentioned in Green's Monograph, p. 80.) Cazenovia, N. Y. *L. C. Beck, Don.*

I, a, 8. Trimerus delphinocephalus, Green. ORIGINAL. (Also Palæontology of New York, vol. 2, pl. 68, fig. 3.) Banks of Lake Ontario, Monroe county, N. Y. *James Eights, Don.*

I, a 9. Trimerus delphinocephalus, Green. (Specimen mentioned in Green's Monograph, p. 82.) Banks of Lake Ontario, Monroe county, N. Y. *M. H. Webster, Don.*

I, a, 10. Calymene Blumenbachii, Brong. Canajoharie, N. Y. *James Eights, Don.*

I, a, 11. Asaphus micrurus, Green. Becraft's Mt., near Hudson, N. Y. *M. H. Webster, Don.*

I, a, 12. Asaphus Wetherilli, Green. ORIGINAL. Rochester, N. Y. *L. C. Beck, Don.*

I, a, 13. (*Calymene callicephala*, Green, Trenton limestone.) Label missing.

I, a, 14. Isotelus gigas, DeKay. Norway, Herkimer county, N. Y. *James Hadley, Don.*

I, a, 15. Isotelus (fragment). Trenton Falls, N. Y. *H. W. Snyder, Don.*

I, a, 16. Two worn specimens of Trilobite (*Calymene callicephala*, Green.) Trenton Falls, N. Y. *M. H. Webster, Don.*

I, a, 17. Calymene Blumenbachii. Trenton Falls, N. Y. *H. W. Bauman, Don.*

I, a, 18. (*Odontocephalus selenurus.* Corniferous limestone.) Label missing.

I, a, 19. Missing.

I, a, 20. Calymene bufo, Green. (Hamilton group. Locality missing.)

I, a, 21. Missing.

I, a, (b), 22. (*Dalmanites pleuruptyx*, Green. Lower Helderberg. The Heldeberg, N. Y.)

I, a, 23. Calymene bufo. (*Phacops Logani*, Hall.) Lower Helderberg limestone. Schoharie, N. Y. *J. Gebhard, Don.*

I, a, 24. Calymene bufo. (Hamilton group. Locality missing.) *C. Delafield, Don.*

I, a, 25. (*Isotelus gigas.* Trenton limestone.) Label missing.

I, a, 26. Calcareous slate with Trilobites (= *Triarthrus Becki*, Green), 7½ miles east of Little Falls, N. Y.

I, a, 27. (*Dalmanites anchiops*, Green. Schoharie grit.) Label missing.

I, a, 28. (*Dalmanites pleuroptyx*, Green. Delthyris shaly limestone.) Label missing.

I, b, 1. Isotelus. ORIGINAL (Palæontology of New York, vol. I, pl. 61, fig. 3g. There identified as *Isotelus gigas*, De Kay, but probably a distinct species). Crown Point, N. Y. *John James, Don.*

I, b, 2. (*Dalmanites pleuroptyx*, Green. Lower Helderberg group. The Helderberg, N. Y.)

I, b, 3. (*Dalmanites limulurus*, Green. Niagara group, Rochester, N. Y.)

I, b, 4. Asaphus caudatus (= *Dalmanites limulurus*. Green). Specimen described in Green's Monograph, p. 56, as *A. pleuroptyx*. Genesee river, N. Y. *James Eights, Don.*

I, b, 5. (*Dalmanites micrurus*, Green. Lower Helderberg group. The Helderberg, N. Y.)

I, b, 6. Asaphus selenurus, Eaton. Corniferous limestone. Helderberg. James Eights.

I, b, 7. Missing.

I, b, 8. Ceraurus pleurexanthemus, Green. 3 specimens. ORIGINALS. Trenton limestone. Newport, N. Y. *T. R. Beck, Don.*

I (II), b, 9. (*Dalmanites micrurus*, Green. ORIGINAL. Lower Helderberg, Schoharie county, N. Y.)

I, b, 10. Tail of Isotelus (*gigas*, De Kay). Trenton limestone. Mastigouche river, Canada. *T. R. Beck, Don.*

I, b, 11. (*Dalmanites micrurus*, Green. Lower Helderberg. The Helderberg, N. Y.)

I, b, 12. (*Dalmanites myrmecophorus*, Green. Corniferous limestone. N. Y.) Label missing. 2 specimens belonging together.

I (II), b, 13. (*Dalmanites pleuroptyx*, Green. ORIGINAL. Lower Helderberg (Shaly limestone), Albany county, N. Y.)

I, b, 14. Asaphus Hausmanni. (=*Phacaps rana*, Green). Eaton coll. Hamilton group. Western, N. Y.)

I, b, 15. Asaphus caudatus (Eaton's label). (?) Oriskany fauna, near Hudson, N, Y.

I, b, 16. Asaphus caudatus (Eaton's label). (?) Oriskany fauna, near Hudson, N. Y.

I, b, 17. Asaphus in Greywacke. South Sea Islands (?) (Probably *Dalmanites* sp. nov. Oriskany fauna, near Hudson, N. Y.) *S. De Witt Bloodgood, Don.*

I, b, 18. (*Dalmanites pleuroptyx*, Green. Lower Helderberg group. Schoharie, N. Y.)

I, b, 19. Asaphus laticostatus, Green (= *Dalmanites pleuroptyx*, Green). Schoharie, N. Y. *J. Gebhard, Don.*

I, b, 20. Asaphus selenurus, Eaton. Corniferous limestone. Schoharie, N. Y. *J. Gebhard*, Don.

I, b, 21. Calymene bufo, Green (= *Phacops cristata*, var. *pipa*). Corniferous limestone. Schoharie, N. Y. *J. Gebhard, Don.*

See I, a, (b), 22.

I, b, 23. (*Dalmanites limulurus:* Green, Lockport,? N. Y.) Label missing.

I, c. 1. Trimerus delphinocephalus. Green. Genesee River, N. Y. *James Eights, Don.*

I, c, 2. Trimerus delphinocephalus. Green. (Specimens described in Green's Monograph, p. 82.) Williamsville (? probably Lockport), N. Y. *J. Hadley, Don.*

I, d, 1. Cryptolithus tesselatus. Green. Four specimens (1 missing). Glens Falls, N. Y. *M. H. Webster, Don.*

Also, Calymene platys. Green. ORIGINAL. Helderberg Mt. Albany county, N. Y. *T. R. Beck, Don.*

Two plaster moulds of Dipleura DeKayi. Green. Cazenovia, N. Y.

6. *Balance of the General Collection.*

These specimens are virtually without other label than the catalogue ticket, and as the catalogue is missing the restoration of localities is in many cases a matter of approximation. The great majority of the specimens, however, are from the State of New York and their origin is not a matter of much uncertainty. In this list the choicer specimens, which are really important additions to the collections of the State Museum are indicated by an asterisk on the margin of the page.

*I, b, 21. *Gonioceras anceps.* Hall. Black River limestone. Watertown, N. Y.

*I, b, 7. *Murchisonia.* Lower Pentamerus limestone. Helderberg.

I, (or II), b, 19, (*Orbiculordea gravdis*, Vanuvem), Oriskany sandstone. The Helderberg, N. Y.

II, b, 1. Lower Helderberg limestone. Helderberg.

II, b, 2. Lower Pentamerus limestone. Helderberg.

II, b, 3. Missing.
II, b, 4. Lower Pentamerus limestone. Helderberg.
II, b, 5. Chert. Lower Carboniferous.
II, b, 6. Clinton group. Tennessee?
II, b, 7. Crinoid columns, Clinton group.
II, b. 8. Missing.
II, b, 9. *Arthrophycus Harlani.* Medina Sandstone. Western N. Y.
*II, b. 10. *Arthrophycus Harlani.* Medina Sandstone.
II, b, 11. Crinoid columns. Chemung group. N. Y.
II, b, 12. Crinoid columns. Chemung group, N. Y.
II, b, 13. Crinoid columns. Niagara group, Wisconsin?
II, c, 1. *Cornulites. Orthis.* Hudson River Sandstone, Niskayuna, N. Y.
II, c, 2. *Cornulites. Orthis. Modiolopsis.* Hudson River Sandstone, Niskayuna, N. Y.
II, c, 3. Crinoid columns. Delthyris Shaly limestone, Berne, N. Y
II, c, 4. Crinoid columns. Corniferous limestone, Eastern N. Y.
III, 2, b, 1. *Schizodus?* Locality? Europe.
III, 2, c, 1. *Gresslya.* Locality? Europe.
III, 2, d, 1. *Cyprina.* Locality? Europe.
III, 2, d, 2. *Glycimeris.* Locality? Europe.
III, 2, g, 2. *Cyprina?* Locality? Europe.
III, 2, k, 1. "Ostracite? West. Dist." *Limoptera macroptera,* Hamilton group, Central N. Y.
III, 2, k, 2. *Limoptera macroptera.* Hamilton group, Central N. Y.
III, 2, k, 3. Missing.
III, 2, k, 4. Missing.
III, 2, k, 5. Missing.
III, 2, k, 6. *Grammysia bisulcata.* Hamilton group, Central N. Y.
III, 2, l, 1. "Pectinite, Helderberg." *Hipparionyx proximus.* Oriskany sandstone.
III, 2, l, 2. "Pectinites in Greywacke." *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.
III, 2, l, 3. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.?
III, 2, l, 4. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.?
III, 2, l, 5. *Spirifer mucronatus,* Conrad. Hamilton group, Rensselaerville, N. Y.

III, 2, l, 6. "Pectinite, West. Dist." *Spirifer granulosus*, Conr. Hamilton group, Western N. Y.

III, 2, l, 7 (2 specimens). "Pectinite, Helderberg." *Spirifer arenosus*, Conr. Oriskany sandstone.

III, 2, l, 8. *Orthis testudinaria.* Trenton limestone, "from Big Sandy Creek, Jefferson county, about two miles above its mouth."

III, 2, l, 9. *Rafinesquina alternata.* Trenton limestone, Central N.Y.

III, 2, l, 10. Missing.

III, 2, l, 11. Missing.

III, 2, l, 12. Missing.

III, 2, l, 13. Missing.

III, 2, l, 14. Missing.

III, 2, l, 15. Belemnite. Locality?

III, 2, l, 16. *Cyprina?* Lias? Locality?

III, 2, l, 17. Missing.

III, 2, l, 18. *Spirifer mucronatus*, Conr. Hamilton group, Central N. Y.

III, 2, l, 19. *S. arenosus*, Conr. Oriskany sandstone, Eastern N. Y.

III, 2, l, 19. S. disjunctus, Sow. Chemung sandstone, N. Y.

III, 2, m. 1. "Anomite, Helderbergh" *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 2. "Anomite, Rensselaerville" *R. ovalis*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 3. *Atrypa reticularis*, Linn. Corniferous limestone, N. Y.

III, 2, m, 4. Missing.

III, 2, m, 5. *Meristella bella*, Hall. Lower Helderberg group, Albany county, N. Y.

III, 2, m, 6. *Atrypa, Meristella, Proetus*, etc. Schoharie grit, Albany county, N. Y.

III, 2, m, 7. Missing.

* III, 2, m, 8. "Anomite, Rensselaerville," *Rensselæria ovalis*, Hall. Oriskany sandstone, N. Y.

* III, 2, m, 9. *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 10. *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 11. Missing.

III. 2, m, 12. "Anomites in argillite," *Liorhynchus limitaris.* Marcellus shale, N. Y.

III, 2, m, 13. "Anomites in limestone, Fairfield, Herkimer county," *Orthis testudinaria.* Trenton limestone, N. Y.

*III, 2, m, 14. *Rensselæria ovoides*, Hall. Oriskany sandstone, N. Y.

III, 2, m, 15. Missing.

*III, 2, m, 16. *Strophomena deltoidea*, Conrad. Trenton limestone, Eastern N. Y.

III, 2, m, 17. Missing.

III, 2, m, 18. *Rhynchonella.* Hamilton group, Albany county? N. Y.

III, 2, m, 19. *Strophomena deltoidea*, Conrad. Trenton limestone, Eastern N. Y.

III, 2, m, 20. *Leptæna* sp.? Trenton limestone, N. Y.

III, 2, m, 21. *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, m, 22. *Rhynchonella.* Chalk flint, England.

III, 2, n, 1. Missing.

III, 2, n, 2. "Gryphite, Bethlehem," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 3. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 4. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

III, 2, n, 5. "Gryphite, Helderberg," *Pentamerus galeatus.* Lower Helderberg group, N. Y.

*III, 2, o, 1. "Terebratulite, Helderbergh," *Spirifer arrectus*, Hall. Oriskany sandstone.

III, 2, o. 2. "Terebratulites, Coeymans," *Spirifer mucronatus*, Conr. Hamilton group.

III, 2, o, 3. "Terebratulites, Rensselaerville," *Tropidoleptus carinatus*, Hall. Hamilton group.

III, 2, o, 4. "Inside of a Terebratulite, Bethlehem," *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone.

III, 2, o, 5. *Spirifer arrectus*, Hall. Oriskany sandstone.

III, 2, o, 6. "Terebratulite, Helderbergh," Spirifer arenosus, Hall. Oriskany sandstone.

III, 2, o, 7. "Terebratulites in Greywacke, Coeymans," *Rhynchonella.* Hamilton group, N. Y.

*III, 2, o, 8. *Spirifer arenosus*, Hall. Oriskany Sandstone, Albany county, N. Y.

III, 2, o, 9. *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone, Albany county, N. Y.

*III, 2, o, 10. *Hipparionyx proximus*, Vanuxem. Oriskany Sandstone, Albany county, N. Y.

*III, 2, o, 11. *Hipparionyx proximus*, Vanuxem. ORIGINAL. Oriskany sandstone, Albany county, N. Y.

III, 2, o, 12. Missing.

III, 2, o, 13. Missing.

III, 2, o, 14. Missing.

III, 2, o, 15. *Spirifer.* Chemung group, N. Y.

III, 2, o, 16. Missing.

III, 2, o, 17. *Zygospira erratica*, Hall, etc. Hudson River group, Central N. Y.

III, 2, p, 1. "Mytilite, West. Dist." *Grammysia arcuata*, Hall. Hamilton group, N. Y.

III, 2, p, 2. *Modiolopis modiolaris.* Hudson River group, Central N. Y.

III, 2, p, 3. *Ambonychia radiata.* "From the high grounds bordering Salmon River, two or three miles from the present shore of Lake Ontario, Oswego co."

III, 2, p, 4. *Lingula cuneata.* Medina standstone, Albion, N. Y.

III, 2, p, 5. *Actinopteria decussata.* Hall. Hamilton group, N. Y.

III, 2, p, 6. *Goniophora Hamiltonensis.* Hamilton group, N. Y.

III, 3, a, 1. *Nautilus.* Triassic, Europe.

III, 3, a, 2. *Ammonites.* Triassic, Europe.

III, 2, p, 8. *Crassatella.* Jurassic, Europe.

III, 2, p, 9. *Crassatella.* Jurassic, Europe.

III, 3, b, 1. *Ammonites.* Jura, Solenhofen?

III, 3, b, 2. *Gyroceras trivolve.* Hall. Corniferous limestone, Schoharie, N. Y.

*III, 3, b, 3. *Gyroceras trivolve* (3 specimens). Corniferous limestone, Schoharie, N. Y.

*III, 3, b, 4. *Gyroceras trivolve* (2 specimens). Corniferous limestone, Schoharie, N. Y.

III, 3, b, 5. *Ammonites.* Jurassic, England.

III, 3, b, 6. *Ammonites* (2 specimens). Jurassic, England.

III, 3, b, 7. *Ammonites.* Jurassic, England.

III, 3, b, 8. *Ammonites.* Jurassic, England.

III, 3, b, 9. *Ammonites.* Jurassic, England.

III, 3, b, 10. *Ammonites.* Jurassic, England.

*III, 3, b, 11. *Goniatites Vanuxemi.* Hall. Goniatite limestone, Schoharie, N. Y.

III, 3, b, 12. *Ammonites.* Jurassic, Europe.

III, 3. b, 13. *Ammonites.* Jurassic, Europe.

III, 3, b, 14. *Ammonites.* Jurassic, Europe.

III, 3, b, 15. *Ammonites.* Jurassic, Europe.

III, 3, b, 16. *Ammonites.* Jurassic, Europe.

III, 3, b, 17. *Ammonites.* Jurassic, Europe.

III, 3, b, 18. *Ammonites.* Jurassic, Europe.

*III, 3, b, 19. *Lituites convolvans.* Hall. ORIGINAL (Palæontology of New York, vol. 1, pl. 13, fig. 2*a*). Black River limestone, Watertown, N. Y.

*III, 3. d, 1. *Endoceras longissimum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 2. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 3. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 4. *Endoceras proteiforme.* Hall. Trenton limestone, N. Y.

III, 3, d, 5. *Endoceras proteiforme.* Hall. Trenton limestone, N. Y.

III, 3, d, 6. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

III, 3, d, 7. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 8. *Endoceras.* Black River limestone, Watertown, N. Y.

*III, 3, d, 9. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 10. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 11. *Endoceras.* Black River limestone, Watertown, N. Y.

*III, 3, d, 12. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 13. *Ormoceras tenuifilum.* Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 14. *Ormoceras tenuifilum.* ORIGINAL. (Palæontology of New York, vol. I, pl. 15, figs. 1, 1*a*, 16, plate 16, fig. 1*a*). Black River limestone, Watertown, N. Y.

III, 3, d, 15. *Endoceras proteiforme*. Hall. Trenton limestone N. Y.

III, 3, d, 16. *Endoceras proteiforme*. Hall. Trenton limestone, N. Y.

*III, 3, d, 17. *Ormoceras tenuifilum*. Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 17. *Ormoceras tenuifilum*. Hall. Black River. ?North shore of Lake Huron.

*III, 3, d, 18. *Ormoceras tenuifilum*. Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 19. *Ormoceras tenuifilum*. Hall. Black River limestone, Watertown, N. Y.

*III, 3, d, 20. *Orthoceras* sp.? Hamilton group, Central N. Y.

III, 3, e, 1. Missing.

III, 3, e, 2. Missing.

III, 3, e, 3. Missing.

III, 3, e, 4. *Belemnites*. Locality ?

III, 3, e, 5. *Belemnites*. Locality ?

III, 3, e, 6. Missing.

III, 3, e, 7. "Belemnites. Pennsylvania."

III, 3, k, 1. "Buccinite Helderbergh." *Loxonema* sp.? Lower Helderberg limestone.

III, 3, n, 1. "Turbinite Helderbergh." *Platystoma* sp. ? Schoharie grit.

III. 3, n, 2. "Turbinite Helderbergh." *Platystoma* sp. ? Schoharie grit.

III, 3, n, 3. *Maclurea* sp. Chazy limestone, N. Y.

III, 3, n, 4. *Platystoma* sp. ? Coniferous limestone, N. Y.

III, 3, n, 5. *Platyceras* sp. ? Schoharie grit, N. Y.

III, 3, n, 6. *Platyceras spirale* Hall. Lower Helderberg group, N. Y.

*III, 3, n, 7. *Lituites undatus*, Hall. ORIGINAL. (Palæontology of New York, vol. I, pl. 13, pp. 1a, 1b.) Black River limestone, Watertown, N. Y.

III, 3, n, 8. *Platystoma*. Corniferous limestone, N. Y.

III, 3, n, 9. Missing.

III, 3, n, 10. *Pleurotomaria sulcomarginata*, Hall. Hamilton group, Central N. Y.

III, 3, q, 1. *Leptæna rhomboidalis*. Locality ?

III, 3, q, 2. *Leptæna rhomboidalis* var. *ventricosa*, Hall. Oriskany limestone, N. Y.

III, 3, q, 3. *Leptæna rhomboidalis*. Coniferous limestone, N. Y.

III, a, a, 1. *Baculites.* Cretaceous. Locality?
III. a, 10. *Spirifer arrectus*, Hall. Oriskany sandstone. The Helderberg, N. Y.
IV, a, 1. *Halysites catenulata.* Niagara group, N. Y.
IV, a, 2. Missing.
IV, a, 3. *Eridophyllum.* Niagara group, N. Y.
IV, a, 4. *Syringopora.* Niagara group, Western N. Y.
IV, a, 5. Missing.
IV, a, 6 (2 specimens). *Columnaria alveolata.* Black River limestone, Eastern N. Y.
IV, b, 1. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 2. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 3. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 4. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 5. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 6. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 7. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 8. *Zaphrentis.* Corniferous limestone, Helderberg.
IV, b, 9. *Heliophyllum.* Corniferous limestone, Helderberg.
IV, b, 10. *Atrypa reticularis.* Corniferous limestone, Helderberg.
IV, b, 11. "Inside of a Cornua-Madreporite, Bethlehem." *Zaphrentis.* Schoharie Grit, N. Y.
IV, b, 12. *Heliophyllum.* Corniferous limestone, N. Y.
IV, b, 13. *Streptelasma rectum*, Hall. Hamilton group, Lake Erie.
IV, b, 14. *Heliophyllum.* Corniferous limestone, N. Y.
IV, b, 15. *Zaphrentis.* Corniferous limestone, N. Y.
IV, b, 16. *Zaphrentis.* Corniferous limestone, N. Y.
IV, b, 17. *Zaphrentis.* Corniferous limestone, N. Y.
IV, b, 18. *Pecten.* Tertiary locality.?
IV, b, 19. Missing.
IV. b, 20. *Heliophyllum Halli*, E. & H. Hamilton group, Western N. Y.
IV, b, 21. Missing.
IV, b, 22. Water worn corals. Hamilton group, N. Y.
IV, b, 23. Coral. Probably European Jurassic.
*IV, b, 24. *Heliophyllum.* Corniferous limestone, N. Y.
IV, b, 25. *Favosites & Zaphrentis.* Corniferous limestone, N. Y.
IV, b, 26. Missing.
IV, b, 27. Organic Impressions. Clinton group (Gray band), Medina, N. Y.
IV, b, 28 (2 specimens). *Zaphrentis.* Corniferous limestone, N. Y

IV, b, 29. Missing.
IV, b, 30. Bryozoa. Trenton limestone, Central N. Y.
IV, b, 31. Bryozoa. Trenton limestone, Central N. Y.
IV, b, 32. *Heliophyllum.* Hamilton group, Western N. Y.
IV, b, 33. *Zaphrentis.* Corniferous limestone, Western N. Y.
IV, b, 34. Missing.
IV, b, 35. *Monticulipora lycoperdon.* Trenton limestone, N. Y.
IV, f, 1. *Favosites.* Corniferous limestone, Helderberg, N. Y.
IV, f, 2. *Favosites.* Corniferous limestone, Bethlehem, N. Y.
IV, f, 3. *Columnaria alveolata.* Black River limestone, N. Y.
IV, f, 4. *Favosites.* Corniferous limestone, Bethlehem, N. Y.
IV, f, 5. *Favosites.* Corniferous limestone, N. Y.
IV, f, 6. *Favosites.* Corniferous limestone, N. Y.
IV, f, 7. *Favosites.* Corniferous limestone, N. Y.
IV, f, 8. *Favosites.* Corniferous limestone, N. Y.
IV, f, 9. *Favosites.* Corniferous limestone, N. Y.
IV, f, 10. *Favosites.* Corniferous limestone.
IV, f, 11. *Favosites.* Niagara limestone.
IV, f, 12. *Favosites.* Corniferous limestone, N. Y.
IV, f, 13. *Favosites.* Corniferous limestone, N. Y.
IV, f, 14. *Favosites.* Corniferous limestone, N. Y.
IV, f, 15. *Favosites.* Corniferous limestone, N. Y.
IV, f, 16. *Favosites.* Niagara limestone, N. Y.
IV, f, 17. Missing.
IV, f, 18. Missing.
IV, f, 19. (3 specimens.) *Favosites.* Niagara limestone, N. Y.
IV, f, 20. Missing.
IV, f, 21. Missing.
IV, f, 22. *Zaphrentis.* Corniferous limestone, N. Y.
IV, f, 23. Missing.
IV, f, 24. *Favosites.* Niagara limestone, N. Y.
IV, f, 25. (2 specimens.) Niagara?
IV, f, 26. *Favosites.* Niagara limestone. Illinois and Wisconsin.
IV, g, 1. Graptolites. Hudson River slates? N. Y.
IV, k, 1. *Eridophyllum.* Corniferous limestone, Berne, N. Y.
IV, k, 2. *Eridophyllum.* Corniferous limestone, Berne, N. Y.
IV, k, 3. *Columnaria alveolata.* Trenton limestone, N Y.
IV, k, 4. *Columnaria alveolata.* Trenton limestone Glens Falls, N. Y.
IV, k, 5. *Columnaria alveolata.* Trenton limestone, Glens Falls, N. Y.

IV, k, 6. *Trachypora.* Corniferous limestone, N. Y.
IV, l, 1. *Syringopora.* Corniferous limestone, Bethlehem, N. Y.
IV, l, 2. *Syringopora.* Corniferous limestone, N. Y.
IV, m, 1. Sponge. Chalk, Wilts, England.
IV, r, 16. *Favosites.* Corniferous limestone, N. Y.
IV, r, 25. *Stromatopora.* Niagara limestone, N. Y.
V, 1. Missing.
V, 2. Water-worn coral.
V, 3. "Veget. Petrefact. in Hornstone. Coeymans." *Trematopora.* Delthyris shaly limestone.
V, 4. "Veget. Petrefact. Helderbergh." Casts of sponge tubes. Oriskany sandstone.
V, 5. "Veget. Petrefact. Helderbergh." Casts of sponge tubes. Oriskany sandstone.
V, 6. Missing.
V, 7. Epsomites. Niagara limestone, N. Y.
V, 8. Epsomites. Niagara limestone, N. Y.
V, 9. Epsomites. Niagara limestone, N. Y.
V, 10–12. Missing.
V, 13. Travertine. Danube, Herkimer county, N. Y.
V, 14–30. Missing.
V, 31. Silicified palm. Locality?
V, 32, 33. Missing.
V, 34. "Ferruginified birch roots. Fowler. St. Lawrence coun'y."
V, 35. Missing.
V, 36. (2 specimens) *Orthoceras* sp.? Marcellus shales, Schoharie, N. Y.
V, 37, 38. Missing.
*V, 39. "*Lithodictuon Beckii,* from Medina, Orleans county, N. Y. (Grey band of Eaton.) Dr. G. W. Boyd."
V, 40, 41. Missing.
V, 42. *Arthophycus Harlani.* (3 specimens.) Medina, N. Y.

1. *Trigonia,* etc. Jurassic. Locality?
2. *Trigonia,* etc. Jurassic. Locality?
4. *Triarthrus Becki.* Green. Utica slate, N. Y.
4. *Orbiculoidea grandis.* Van. Hamilton group, Central N. Y.
4. *Streptelasma,* etc. Hamilton group, Western N. Y.
5. Corniferous limestone, N. Y.
5. *Scolithus.* Potsdam sandstone, N. Y.

*6+20+21+26. *Endoceras longissimum.* Hall. ORIGINAL. (Palæontology of New York, vol. I, pl. 18, figs. 1, 1a.) Black River limestone, Watertown, N. Y.

*7. *Gonioceras anceps.* Hall. Black River limestone, Watertown, N. Y.

8. *Murchisonia bellicincta.* Trenton limestone, Central N. Y.

9. *Murchisonia bellicincta.* Trenton limestone, Central N. Y.

10. *Edmondia subtruncata.* Hall. Trenton limestone, Central N. Y.

10. *Orthoceras,* Schoharie grit, N. Y.

11+13. *O. junceum,* Hall. Trenton limestone, Central N. Y.

12. *Edmondia subtruncata,* Hall. Trenton limestone, Central N. Y.

14. *Monticulipora.* Trenton limestone, Central N. Y.

15. *M. lycoperdon.* Trenton limestone, Central N. Y.

*16+23. *Gonioceras anceps,* Hall. Black Biver limestone, Watertown, N. Y.

18. *Monticulipora.* Trenton limestone, N. Y.

*19. *Gonioceras anceps,* Hall. Black River limestone, Watertown, N. Y.

21. Pentamerus limestone, Rochester, N. Y.

*22. *Ormoceras ? gracile,* Hall. ORIGINAL. (Palæontology of New York, vol. 1, pl. 17, fig. 3.) Black River limestone, Watertown, N. Y.

25. *Stromatocerium rugosum,* Hall. Watertown, N. Y.

26. *Tetradium.* Watertown, N. Y.

27. *Stromatocerium rugosum,* Hall. Watertown, N. Y.

*28. *Endoceras proteiforme,* var. *tenuistriatum,* Hall. Trenton limestone, Central N. Y.

29. *Edmondia subtruncata,* Hall. Trenton limestone, Central N. Y.

31. *Pterinea flabella,* Conr. Hamilton group, Central N. Y.

45. *Spirifer arrectus,* Conr. Oriskany sandstone, N. Y.

136. *Halysites catenulata.* Niagara group, N. Y.

SPECIMENS WITH PRINTED NUMBERS.

445, 471, 502. *Spirifer mesastrialis,* Hall. *Modiomorpha* and other fossils. Chemung group, N. Y.

58, 376, 424. *Limoptera macroptera,* Conr. Hamilton group, N. Y.

53. *Spirifer.* Lower Carboniferous. Locality?

119. *Heliophyllum Halli,* E. & H. Hamilton group, Western N. Y.

72, 304. *Orthoceras.* Hamilton group, Central N. Y.

444, 454, 81, 464. *Spirifer granulosus,* Conr. Hamilton group, Central N. Y.

43. *S. audaculus*, Conr. Hamilton group, Central N. Y.
71. *Cimitaria recurva*, Conr. Hamilton group, Central N. Y.
84. *Spirifer mucronatus*, Conr. Hamilton group, Rensselaerville, N. Y.
22. *Favosites*. Niagara group, N. Y.
*a. Potsdam sandstone, N. Y.
b. *Pholadomya*. Jurassic, Europe.
b. *Zaphrentis*. Corniferous limestone, N. Y.
c. *Cucullæa*. Cretaceous, Europe.
c. *Columnaria*. Black River limestone, N. Y.
d, f. *Monticulipora lycoperdon*. Trenton limestone, N. Y.
*e. *Orthoceras nuntium*, Hall. Hamilton group, Central N. Y.
k. *Leptæna rhomboidalis*, Wilck. Corniferous limestone, N. Y.
0.1 ? Corniferous, Ky.
0.3. ? Corniferous, Ky.
t, u, v. Various fossils. Hudson River group (erratic blocks), N. Y.
a, a. (Two specimens) *Monticulipora lycoperdon*. Trenton limestone, N. Y.
*b, b. *Tentaculites gyracanthus*, Eaton. Tentaculite limestone, Schoharie, N. Y.
c, c. *Grammysia arcuata*, Conr. Hamilton group, N. Y.
d, d. Cetacean? bones. Locality?
e, e. Silicified wood. Locality?
f, f. *Batrachoides nidificans*, Hitchcock. Triassic sandstone, Connecticut Valley, Mass.
g, g. Various fossils. Hamilton group, N. Y.
h, h. *Orthoceras undulatum*, Hall. Niagara limestone, Western New York.
o, o. *O. Marcellense*, Hall. Goniatite limestone, Schoharie, N. Y.
N. 1. *Conocardium trigonale*, Conr. Corniferous limestone, Schoharie, N. Y.?
N. 2. *Leperditia alta*, Conr. Tentaculite limestone, Schoharie, N. Y.
N. 3. Corniferous limestone, Schoharie, N. Y.
*N. 4. *Favosites tuberosa*, Rom. Corniferous limestone, Schoharie, N. Y.
N. 5. *Zaphrentis*. Corniferous limestone, Schoharie, N. Y.
N. 6. *Favosites*. Corniferous limestone, Schoharie, N. Y.
N. 7. *Platyceras dumosum*, Conr. Corniferous limestone, Schoharie, harie, N. Y.
N. 8. *Megambonia bellistriata*, Hall. Oriskany limestone, Schoharie, N. Y.

*N. 9. *Terebratula?* Corniferous limestone, Schoharie, N. Y.
*N. 10. *Ptilodictya.* Corniferous limestone, Schoharie, N. Y.
N. 11. *Favosites tuberosa*, Rom. Corniferous limestone, Schoharie, N. Y.
N. 12. *Favosites.* Corniferous limestone, Schoharie, N. Y.?
N. 13. *Pterinæa arenaria*, Hall. Oriskany sandstone, Schoharie, N. Y.
E. 3. Fish tooth. Locality?
E. 4. Fish tooth. Locality?
E. 7. Fish tooth. Locality?
E. 6. Fish tooth. Locality?
E. 9. Fish tooth. Locality?
G. *Trinucleus concentricus.* Trenton limestone, N. Y
G. Hamilton group?
H. *Trinucleus concentricus.* Trenton limestone, N. Y.
I. *Leptæna rhomboidalis.* Corniferous limestone, N. Y.
I. *Edmondia subtruncata*, Hall. Trenton limestone, N. Y.
L. ? ?
M. ? ?
P. 1. Pentamerus limestone. Clinton group. Western, N. Y.
P. 2. *Spirifer granulosus*, Conr. Hamilton group, N. Y.
P. 3. *Conocardium.* Corniferous limestone, N. Y.
P. 4.
P. 5. *Limoptera?* Hamilton group, N. Y.
P. 6. *Spirifer granulosus*, Conr. Hamilton group, N. Y.
P. 7. *Orthoceras crotalum*, Hall. Hamilton group, N. Y.
S. *Pentamerus oblongus*, Hall. Clinton group, Rochester, N. Y.
X. *Astarte.* Cretaceous. Locality.?

FOSSILS WITHOUT LABELS OR TICKETS.

Columnaria alveolata (2 specimens). Black River limestone, N. Y.
Bellerophon bilobatus Conr. Trenton limestone, N. Y.
Raphistoma lenticulare. Trenton limestone, N. Y.
Orthis biforata Eich. Hudson River group, Ohio.
Ambonychia radiata. Hudson River group, N. Y.
Cyrtolites ornatus. Hudson River group, N. Y.
**Pleurotomaria? pervetusta*, Hall. Medina sandstone, N. Y.
Pentamerus oblongus var. Niagara group, Iowa.
Caryocrinus ornatus, Hall (2 specimens). Niagara group, Lockport, N. Y.
Spirifer Niagarensis, Hall. Niagara group.

Halysites catenulata. Niagara group, N. Y.
Epsomites. Niagara group, N. Y.
Spirifer macropleura, Conrad. Lower Helderberg group, N. Y.
Meristella lævis, Hall. Lower Helderberg group, N. Y.
Leperditia alta, Conrad. Lower Helderberg group, N. Y.
Pentamerus galeatus, Dal. Lower Helderberg group, N. Y.
Spirifer arenosus, Conr. Oriskany sandstone, N. Y.
S. arrectus, Hall (2 specimens). Oriskany sandstone, N. Y.
Rensselæria ovoides, Hall (3 specimens). Oriskany sandstone, N. Y.
R. ovalis, Hall. Oriskany sandstone, N. Y.
Eatonia peculiaris, Hall (2 specimens). Oriskany sandstone, N. Y.
Orthoceras. Schoharie grit, N. Y.
Atrypa reticularis (19 specimens). Corniferous limestone, N. Y.
One lot corals (15 specimens). Corniferous limestone, N. Y.
Athyris spiriferoides Eaton (34 specimens). Hamilton group, Western N. Y.
One misc. lot brachiopods (15 specimens). Hamilton group, Western N. Y.
Grammysia alveata. Hamilton group, Western N. Y.
Cimitaria recurva. Hamilton group, Western, N. Y.
Limoptera macroptera (2 specimens). Hamilton group, Western N. Y.
One lot corals (10 specimens). Hamilton group, Western N. Y.
Misc. brachiopods (4 specimens). Chemung group, N. Y.
One lot Tertiary fossils. Locality?
One lot carboniferous plants from Carbondale, Pittston, Plymouth, etc., Penna. (58 specimens).
One lot carboniferous plants from Morgan county, Virginia.
Palæoniscus, Trias. Turner's Falls, Mass.
Skeleton of fish (2 specimens). Solenhofen, Germany.
Favosites. Niagara limestone, N. Y.
**Orthoceras arcuoliratum*, Hall. Trenton limestone, Wisconsin.

Report of the Assistant Palæontologist.

ALBANY, NEW YORK, *September* 30, 1891.

JAMES HALL, LL. D., *State Geologist.*

SIR.—Early in the present year I received instructions to devote my time as far as possible to the requirements of the Palæontology of New York; as a necessary consequence museum work among the palæontological collections has progressed but little during the past year. The mounting of the crustacean collection has been advanced beyond its condition at date of last report, but still lacks considerably of completion. Important additions have, however, been made to the collections, and of these a list is communicated with this report. Opportunity for field work has been curtailed by the heavy expenditure connected with the geological investigations carried on at the Livonia salt shaft, which has been borne entirely by this department. We have received from Mr. D. D. Luther, who has conducted these investigations, one shipment of specimens, consisting of nineteen boxes and one barrel of fossils, mostly from the upper layers of the Hamilton shales, and a second lot of nine boxes from the middle part of this formation. At the time Mr. Luther began his work in May last, the excavation of the shaft had proceeded to a depth of about 350 feet; of this thickness about 125 feet pertained to the Hamilton shales, the rock section from 225 feet upward being wholly in the Genesee shales. The latter have furnished but the few, common species of the dark shales, the *styliola limestone* layer, which appears in the sections further to the east, being here represented by a few isolated concretions of small size. The fossils of the upper Hamilton shales collected from the dump of the shaft, representing the section from 225–350 feet, have been examined and identified by me, and a list of these with the other fossils of this series of formations will be submitted when a final report on this interesting section shall

be rendered. The material thus far examined has been found very rich in trilobites, linguloids and lamellibranchs; the linguloids especially being remarkable for their diversity of form and beauty of preservation.

Late in the autumn of last year Mr. Jacob Van Deloo made some collections of fossils from the Chazy limestone at Keeseville, and in September of this year he, with Mr. Martin Sheehy, collected considerable valuable material from the interesting Oriskany fauna on Becraft's Mountain, near Hudson, discovered last year by Dr. C. E. Beecher of New Haven.

About a year ago I began the preparation of a series of lists of the type and illustrated specimens of fossils belonging to the Museum collections. The lists heretofore published have been fragmentary and scattered; it has been my purpose to bring together in a zoological arrangement an enumeration, complete to date, of these important specimens, with citations to the publications in which they have been figured. I transmit herewith the first installment of this catalogue, viz., Part I, *Crustacea.*

The work done on the Palæontology of New York, vol. VIII, parts 1 and 2, is fully recounted in your own report.

I am, sir, very respectfully yours.

J. M. CLARKE,
Assistant Palæontologist.

DEPARTMENT OF GEOLOGY AND PALÆONTOLOGY.

List of the Original and Illustrated Specimens in the Palæontological Collections

PART I.---CRUSTACEA.

PREPARED BY JOHN M. CLARKE, ASSISTANT PALÆONTOLOGIST.

PREFATORY NOTE.

The fundamental arrangement in this list is a zoological one; the subordinate arrangement of species under genera is chronological. The combinations of generic and specific names are those adopted in the work where the species have been most fully discussed and illustrated. For the classification of the genera, however, the writer is alone responsible. The collections of the Museum include a considerable number of reproductions in plaster-of-paris, gutta-percha and sulphur, of original specimens, and these are, for convenience of reference, included in the list, but the citations of these are marked with an asterisk (*) in the margin of the page. The actual original specimens, including those used for the first illustration of the species, are indicated by having the reference to the illustration in heavy-face type.

OSTRACODA.

Family LEPERDITIDÆ.

Genus LEPERDITIA, Rouault. 1851.

Leperditia Hudsonica, Hall. 1859.

Palæontology of New York, vol. iii, p. 375.

ırterly Journal of the Geological Society, vol. xlvi, pl. 1, figs. 5, c.

ver Helderberg group (Shaly limestone). Becraft's Mountain,

Leperditia alta, Conrad (sp.). 1843.

anuxem's Report on the Third Geological District of New York, p. 112.

ırterly Journal of the Geological Society, vol. xlvi, pl. 1, figs. 6,

ver Helderberg group (Tentaculite limestone). Herkimer county,

Genus BEYRICHIA, McCoy. 1844.

Beyrichia trisulcata, Hall. 1859.

Palæontology of New York, vol. iii, p. 381.

ırterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. 2.

ver Helderberg group (Tentaculite limestone). Herkimer county,

J. Gebhard purchase.

Beyrichia granulata, Hall. 1859.

Palæontology of New York, vol. iii, p. 377.

ırterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. 3.

ver Helderberg group (Pentamerus limestone). Schoharie county,

J. Gebhard purchase.

Beyrichia oculina, Hall. 1859.

Palæontology of New York, vol. iii, p. 378.

ırterly Journal of the Geological Society, vol. xlvi, pl. 1, fig. 4.

ver Helderberg group (Pentamerus limestone). Schoharie county,

J. Gebhard purchase.

Beyrichia parasitica Hall, (sp.). 1859.

Palæontology of New York, vol. iii, p. 376.

Quarterly Journal of the Geological Society, vol. xlvi, p. 17, fig. 1.

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y. *J. Gebhard purchase.*

Beyrichia Clarkii, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 17, fig. 2.

Lower Helderberg group (Tentaculite limestone). Herkimer county, N. Y. *J. Gebhard purchase.*

Beyrichia subquadrata, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 537, pl. xx, fig. 4.

Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Beyrichia Kluedeni, McCoy. var.

Quarterly Journal of the Geological Society, vol. xlvi, p. 538, pl. 21, fig. 1a, b.

Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Beyrichia Kolmodini, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 538, pl. 20, fig. 6.

Hamilton group. Clarke county, Indiana.
J. M. Clarke purchase.

Genus PRIMITIA, Jones and Holl, 1865.

Primitia Clarkii, Jones. 1890.

Quarterly Journal of the Geological Society, vol. xlvi, p. 535, pl. 21, fig. 11.

Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Genus KLŒDENIA, Jones and Holl. 1886.

Klœdenia notata, Hall (sp.), var. *ventricosa*, Hall. 1859.

Palæontology of New York, vol. iii, p. 380.

Quarterly Journal of the Geological Society, vol. xlvi, p. 14, pl. 1, figs. 1, a, b.

Lower Helderberg group (Shaly limestone). Herkimer county, N. Y.
J. Gebhard purchase.

Genus BOLLIA, Jones and Holl. 1886.

Bollia bilobata, Jones. 1890.

arterly Journal of the Geological Society, vol. xlvi, p. 540, pl. 20, **2.**

rniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus MOOREA, Jones and Kirby.

Moorea Kirbyi, Jones. 1890.

arterly Journal of the Geological Society, vol. xlvi, p. 542, pl. 20, , a, b.

rniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Genus OCTONARIA, Jones.

Octonaria Linnarssoni, Jones. 1890.

arterly Journal of the Geological Society, vol. xlvi, p. 541, pl. 20, , a, b.

milton group. Clarke county, Indiana.

J. M. Clarke purchase.

Genus EURYCHILINA, Ulrich.

Eurychilina reticulata, Ulrich (Jones. 1890).

arterly Journal of the Geological Society, vol. xlvi, p. 539, pl. 20. 3, a, b.

·niferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

CIRRIPEDIA.

Family LEPADIDÆ.

Genus TURRILEPAS, Woodward. 1865.

Turrilepas flexuosus, Hall. 1888.

Palæontology of New York, vol. vii, p. 215, pl. 36, fig. **1.**
Corniferous chert. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas cancellatus, Hall. 1888.

Palæontology of New York, vol. vii, p. 216, pl. 36, fig. **2.**
Corniferous chert. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas devonicus, Clarke. 1882.

American Journal of Science, vol. xxiv, p. 55, fig. **1.**
Palæontology of New York, vol. vii, 1888, pl. 36, fig. **3.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Turrilepas squama, Hall. 1888.

Palæontology of New York, vol. vii, p. 217, pl. 36, fig. **5.**
Palæontology of New York, vol. vii, pl. 36, fig. **6.**
Palæontology of New York, vol. vii, pl. 36, fig. **7.**
Palæontology of New York, vol. vii, pl. 36, fig. **8.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas foliatus, Hall. 1888.

Palæontology of New York, vol. vii, p. 218, pl. 36, fig. **15.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas nitidulus, Hall. 1888.

Palæontology of New York, vol. vii, p. 218, pl. 36, fig. **4.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase

Turrilepas tener, Hall. 1888.

Palæontology of New York, vol. vii, p. 219. pl. 36, figs. **9, 10, 11, 12, 13.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, pl. 36, fig. **14.**
Hamilton group, Canandaigua lake, N. Y.
J. M. Clarke purchase.

Turrilepas ? Newberryi, Whitfield. 1882.
Annals N. Y. Academy of Sciences, vol. ii, no. 8, p. 217.
*Palæontology of New York, vol. vii, pl. 36, fig. **17.**
*Palæontology of New York, vol. vii, pl. 36, fig. **19.**
Erie shale. Sheffield, Ohio.

Genus STROBILEPIS, Clarke. 1888.

Strobilepis spinigera, Clarke. 1888.

Palæontology of New York, vol. vii, p. 212, pl. 36, figs. **20, 21, 22.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1861.

Family **BALANIDÆ.**

Genus PALÆOCREUSIA, Clarke. 1888.

Palæocreusia devonica, Clarke. 1888.

Palæontology of New York, vol. vii, p. 210, pl. 36, figs. **24, 25, 26.**
Corniferous limestone. LeRoy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1878.

TRILOBITA.

Family NUTTAINIIDÆ.

Genus NUTTAINIA, Eaton. 1832.

**Nuttainia concentrica*, Eaton. 1832.

Monograph of the Trilobites of North America, p. 73. Cast No. **28.**
Trenton limestone. Near Waterford, N. Y.
The Albany Institute donor.

Family CALYMENIDÆ.

Genus CALYMENE, Brongniart. 1822.

**Calymene callicephala*, Green. 1832.

Monograph of the Trilobites of North America, p. 30. Cast No. **2.**
Hudson River group. Locality said to be Hampton, Virginia.
The Albany Institute donor.

*(*C. Blumenbachi* [Brongniart] Green).

Monograph of the Trilobites of North America, p. 28. Cast No. **1.**
Trenton limestone. Trenton Falls, N. Y.
The Albany Institute donor.

Calymene camerata, Conrad. 1842.

Journal Philadelphia Academy Natural Science, vol. viii, p. 278.

Palæontology of New York, vol. ii, 1852, pl. 78, fig. **1a.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. ii, 1852, pl. 78, fig. **1b.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. ii, 1852, pl. 78, figs. **1c, 1e.**
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Calymene platys, Green. 1832.

Monograph Trilobites of North America, p. 32.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 3; and
ology of New York, vol. vii, 1888, pl. 1 fig. 1.
arie grit. Schoharie, N. Y.

J. Gebhard purchase.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. **2**; and
ology of New York, vol. vii, 1888, pl. 1, fig. **2**.
arie grit. Albany county, N. Y.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, figs. 4, 7,
ontology of New York, vol. vii, 1888, pl. figs. 3, 7.
arie grit. Schoharie, N. Y.

J. Gebhard purchase.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 5; and
ology of New York, vol. vii, 1888, pl. fig. 4.
arie grit. Schoharie, N. Y.

J. Gebhard purchase.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 6; and
ology of New York, vol. vii, 1888, pl. 1, fig. 5.
arie grit. Schoharie, N. Y.

Collected by C. Van Deloo. 1862.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 1; and
ology of New York, vol. vii, 1888; pl. 1, fig. 6.
arie grit. Knox, N. Y.

Collected by C. Van Deloo. 1862.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 9; and
ology of New York, vol. vii, 1888, pl. 1, fig. 8.
arie grit. Schoharie county, N. Y.

J. Gebhard purchase.

ations of Devonian Fossils, 1876; Crustacea, pl. 1, fig. 8; and
ology of New York, vol. vii, 1888, pl. 1, fig. 9.
arie grit. Schoharie county, N. Y.

Genus HOMALONOTUS, Kœnig. 1825.

Sub-genus TRIMERUS, Green, 1832.

Homalonotus delphinocephalus, Green. 1832.

Monograph of the Trilobites of North America, p. 82, pl. 1, fig. **1**; original of Cast No. **32.**

Niagara group. "In limestone. Banks of Lake Ontario, Monroe county, N. Y."

The Albany Institute donor.

Monograph of the Trilobites of North America, p. 82; not figured.
Niagara group. Western New York.

The Albany Institute donor.

Palæontology of New York, vol. ii, 1852, pl. 68, fig. **9.**
Niagara group. Lockport, N. Y.

Homalonotus Vanuxemi, Hall. 1859.

Palæontology of New York, vol. iii, p. 352, pl. 73, fig. **12.**
Lower Helderberg group. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 5b, figs. 1, 2.
Lower Helderberg group. Kingston, N. Y.

L. Bevier, exchange.

Homalonotus major, Whitfield. 1885.

Bull. Amer. Mus. Nat. His. Vol. i, No. 6, p. 193, pl. 22.

Palæontology of New York, vol. vii, 1888, pl. 5a, fig. 1.
(Oriskany sandstone). Bank of 4th Binnewater, Rosendale, N. Y.

L. Bevier, exchange.

Subgenus DIPLEURA, Green. 1832.

Homalonotus DeKayi, Green (sp.). 1832.

Monograph of the Trilobites of North America, p. 80, not figured.
Hamilton group. Madison county, N. Y.

The Albany Institute donor.

(*) (*Nuttainia sparsa*, Eaton.)

Geological Text-book, 2nd ed., 1832, p. 34.

Monograph of the Trilobites of North America, p. 89, Cast No. **35.**
Hamilton group. Coeymans, N. Y.

The Albany Institute donor.

(*) Monograph of the Trilobites of North America, p. 79, Cast No. **31.**
Hamilton group. Northumberland, Pa. (?)
The Albany Institute donor.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 1.
Hamilton group. Madison county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 2.
Hamilton group. Ladd's quarry near Sherburne, Chenango county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 6.
Hamilton group. Madison or Otsego county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 7; and Palæontolgy of New York, vol. vii, 1888, pl. 2, fig. 7.
Hamilton group. Madison county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, figs. 8, 9; and Palæontology of New York, vol. vii, 1888, pl. 2, figs. 8, 9.
Hamilton group. Madison county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 11.
Hamilton group. Darien, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illusfrations of Devonian Fossils, 1876; Crustacea, pl. 2, fig. 12; and Palæontology of New York, vol. vii, 1888, pl. 2, fig. 12.
Hamilton group. Cazenovia, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 1.
Hamilton group. Bellona, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 2; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 2
Hamilton group. Near Leonardsville, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 3; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 3.
Hamilton group. Madison county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 4; and Palæontology of New York, vol. vii. 1888, pl. 3, fig. 4.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 3, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 3, fig. 5.
Hamilton group. Madison county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 4, figs. 3, 4, 5; and Palæontology of New York, vol. vii, 1888, pl. 4, figs. 1, 2, 3.
Hamilton group. Madison county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 4, fig. 6.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 4, fig. 7.
Hamilton group. Canandaigua Lake. N. Y.
J. M. Clarke purchase.

Palæntology of New York, vol. vii, 1888, pl. 5, fig. 1.
Hamilton group. Pratt's Falls, N. Y.
Collected by C. Van Deloo and H. H. Smith, 1873.

Palæontology of New York, vol. vii, 1888, pl. 5, figs. 2, 3.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 5, figs. 10, 9, and Palæontology of New York, vol. vii, 1888, pl. 5, figs. 12, 13.
Hamilton group. Hamilton, N. Y.
Collected by James Hall, 1862.

Family ASAPHIDÆ.

Genus BUMASTUS, Murchison.

Illœnus Ioxus, Hall. 1867.

Twentieth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 378.

enth Annual Report of the Department of Geology and Natural
y (Indiana), 1882, pl. 33, fig. 13.
gara group. Waldron, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

enth Annual Report of the Department of Geology and Natural
y (Indiana) 1882, pl. 33, fig. 14.
gara group. Waldron, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Illœnus arcturus, Hall. 1847.

eontology of New York, vol. i, p. 23, pl. iv bis., fig. **12.**
zy limestone. Chazy, N, Y.
Geological Survey Collection.

Genus BATHYURUS, Billings. 1865.

Bathyurus extans, Hall. 1847.

eontology of New York, vol. i, p. 228, pl. lx, figs. **2, a, b.**
seye limestone. Watertown, N. Y.
J. Gebhard purchase.

Genus ASAPHUS, Brongniart. 1822.

Asaphus obtusus, Hall. 1847.

eontology of New York, vol. i, p. 24, pl. iv bis., fig. **14.**
zy limestone. Chazy, N. Y.
Geological Survey Collection.

Asaphus canalis (Conrad), Hall. 1847.

eontology of New York, vol. i, p. 25, pl. iv bis., fig. **17.**
zy limestone. Chazy, N. Y.
Geological Survey Collection.

eontology of New York, vol. i, pl. iv bis., fig **19.**
zy limestone. Chazy, N. Y.
Geological Survey Collection.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **19**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **26**.
Schoharie grit. Schoharie, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **16**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **27**.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **18**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **28**.
Corniferous limestone. Near Clarence, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 6, fig. **17**; and Palæontology of New York, vol. vii, 1888, pl. 6, fig. **29**.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1861.

(*) Palæontology of New York, vol. vii, 1888, pl. 8a, figs. 1, 2.
Schoharie grit. Albany county, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 3.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Palæontolgy of New York, vol. vii, 1888, pl. 8a, fig. 4.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Phacops cristata var. *pipa*, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 18, pl. 8a, fig. **5**.
Corniferous limestone. LeRoy, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, 1888, pl. 8a, fig. **9**.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

(*) Palæontology of New York, vol. vii, plate 8a, fig. **10**.
Corniferous limestone. North Cayuga, Ontario.

Palæontology of New York, vol. vii, pl. 8a, figs. **11, 12.**
Corniferous limestone. Walpole, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, pl. 8a, fig. **14.**
Corniferous limestone. Lime Rock, near LeRoy, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, pl. 8a, fig. **15.**
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, pl. 8a, fig. **17.**
Oriskany sandstone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, pl. 8a, fig. **18.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 31.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, figs. 25, 26.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Phacops bufo, Green. 1832.

(*) Monograph of the Trilobites of North America, p. 41, Cast No. **10.**
Illustration of Devonian Fossils, 1875; Crustacea, pl. 8, figs. **24, 25**; and Palæontology of New York, vol. vii, 1888, pl. 8, figs. **25, 26.**
Hamilton group. New Jersey.
The Albany Institute donor.

Phacops rana, Green. 1832.

Monograph of the Trilobites of North America, 1832, p. 42; originals of Casts Nos. **11** and **12.**
Hamilton group. Seneca, Ontario county, N. Y.
The Albany Institute donor.

(*) (*Calymene macrophthalma* (Brongniart), Green=*C. bufo*, Green.)

Monograph of the Trilobites of North America, 1832, pp. 39, 41, Cast No. 9.

Hamilton group. Locality?

The Albany Institute donor.

Illustrations Devonian Fossils, 1876; Crustacea, pl. 7, fig. 1; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 1.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 5.

Hamilton group. Darien, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 9; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 6.

Hamilton group. Geneseo, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, figs. 6, 7; and Palæontology of New York, vol. vii, 1888, pl. 7, figs. 7, 8.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 7, fig. 9.

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 7, figs. 10, 11 and Palæontology of New York, vol. vii, 1888, pl. 7, figs. 10, 11.

Hamilton group. Canandaigua Lake.

Collected by R. P. Whitfield and C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 11.

Hamilton group. Darien, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 12; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 13.
Hamilton group. Geneseo, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 8, fig. 15.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 8, figs. 15, 16; and Palæontology of New York, vol. vii, 1888, pl. 8, figs. 16, 17.
Hamilton group. Canandaigua Lake, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1858.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 21.
Hamilton group. Eighteen-mile Creek, N. Y.
F. A. Randall purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 22.
Hamilton group. Darien, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 28.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 29.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 30.
Hamilton group. Fultonham, N. Y.
Collected by W. M. Gabb, 1857.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 31.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 32.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 8a, fig. 33.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 8.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii. 1888, pl. 21, fig. 9.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 10.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 15.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 17.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 19.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 20.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 21.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 30.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Phacops anceps, Clarke. 1890.

As Trilobitas do Grez de Ereré e Maecurú, Estado do Pará, Brazil, p. 16, pl. 1, fig. 3.
Corniferous limestone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Genus ODONTOCHILE, Corda. 1847.

Dalmanites vigilans, Hall. 1861.

Rept. Progress. Geol. Surv, Wisconsin, p. 57.

Eleventh Annual Report of the Department of Geology and Natural History (Indiana), 1882, pl. 83, fig. 9.

Niagara group. Waldron, Indiana.

Collected by C. D. Walcott and C. Van Deloo, 1878.

Dalmanites limulurus, Green. 1832.

(*Asaphus Wetherilli*, Green.)

Monograph of the Trilobites of North America, p. 57; original of Cast No. **20.**

Niagara limestone. Rochester, N. Y.

The Albany Institute donor.

(*Asaphus pleuroptyx*, Green.)

Monograph of the Trilobites of North America, p. 56; not figured.

Niagara limestone. Genesee River, N. Y.

The Albany Institute donor.

Dalmanites pleuroptyx, Green (sp.) 1832.

Monograph of the Trilobites of North America, p. 55; original of cast No. **18.**

Lower Helderberg group. Schoharie, N. Y.

The Albany Institute donor.

Palæontology of New York, vol. iii, 1859; pl. 74, fig. 6.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 74, fig. 7.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 1.

Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1883, pl. 11a, fig. 3.

Corniferous limestone. Lime Rock, near LeRoy, N. Y.

Ward and Howell purchase.

Dalmanites micrurus, Green (sp.). 1832.

Monograph of the Trilobites of North America, p. 56, fig. **3**; original of Cast No. **19.**

Lower Helderberg group. The Helderberg, N. Y.

The Albany Institute donor.

Palæontology of New York, vol. iii, pl. 74, figs. 1, 2. (*Dalmania pleuroptyx.*)

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, text, p. 359, woodcut.

Lower Helderberg group (Shaly limestone). Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites glabratus, Green. 1832.

(*) Monograph of the Trilobites of North America, p. 52, Cast No. **17.**

Horizon uncertain. Locality said to be Ripley, Ohio.

The Albany Institute donor.

Dalmanites Meeki, Walcott. 1884.

Pal. Eureka Dist., p. 207, pl. 17, figs. 5, a, b.

(*) Palæontology of New York, vol. vii, pl. 11a, fig. **28.**

Lower Devonian. Eureka District, Nevada.

(*) Palæontology of New York, vol. vii, pl. 11a, figs. **29, 30.**

Lower Devonian. Eureka District, Nevada.

Dalmanites concinnus, Hall. 1876.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. **3**; and Palæontology of New York, vol. vii, 1888, pl. 11a, fig. **9.**

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, figs. **4, 5**; Palæontology of New York, vol. vii, pl. 11a, figs. **10, 11.**

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites phacopty.r, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 31, pl. 11a, figs. **23, 24.**

Upper Helderberg group. North Cayuga, Ontario.

Collected by J. De Cew, **1866.**

Palæontology of New York, vol. vii, pl. 11a, fig. **26**.
Upper Helderberg group. North Cayuga, Ontario.
Collected by J. De Cew, 1866.

Dalmanites anchiops, Green (sp.). 1832.
Monog. Tril. North Amer. p. 35.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, figs. 3, 4, and Palæontology of New York, vol. vii, 1888, pl. 9, figs. 2, 3.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, figs. 5, 6, 9; and Palæontology of New York, vol. vii, 1888, pl. 9, figs. 4, 5, 6; pl. 10, fig. **4**.
Schoharie grit. Schoharie county, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. 12.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 5.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, figs. 10, 11; and Palæontology of New York, vol. vii, 1888, pl. 10, figs. 8, 9.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 10, fig. 10.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 13, and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 12.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils. 1876; Crustacea, pl. 10, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 10, fig. 13.
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **12**; Palæontology of New York, vol. vii, 1888, pl. 9, fig. **13.**
Schoharie grit. Ulster county, N. Y.

Dalmanites anchiops, var. *armatus*, Hall. 1861.

Fifteenth Ann. Rept. N. Y. State Cab. Nat. Hist., p. 56.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **12**; and Palæontology of New York, vol. ii, 1888, pl. 9, fig. **7.**
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **7**; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. **8.**
Schoharie grit. Near Clarksville, N. Y.

Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils. 1876; Crustacea, pl. 9, fig. **8**; and Palæontology of New York, vol. vii, 1888, pl. 9, fig. **9.**
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites anchiops, var. *sobrinus*, Hall. 1888.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 9, fig. **11**; and Palæontology of New York, vol. vii, 1888, p. 62, pl. 9, fig. **11.**
Schoharie grit. Schoharie, N. Y.

Collected by C. Van Deloo, 1862.

Dalmanites macrops, Hall. 1861.

Descr. New Species Fossils, etc., p. 59.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, figs. **9, 10**; and Palæontology of New York, vol. vii, 1888, pl. 11a, figs. **14, 15.**
Corniferous limestone. Schoharie, N. Y.

J. Gebhard purchase.

Dalmanites erina, Hall. 1861.

Descr. New Species Fossils, etc., p. 62.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, figs. **3, 4**; and Palæontology of New York, vol. vii, 1888, pl. 11a, figs. **16, 17.**
Corniferous limestone. Clarence, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 18.
Corniferous limestone. Boulder in town of Naples, N. Y.
J. M. Clarke purchase.

Dalmanites Calypso, Hall. 1861.

Descr. New Species Fossils, etc., p. 61.

(*) Palæontology of New York, vol. vii, 1888, pl. 11a, figs. 19, 20.
Corniferous limestone. Sandusky, Ohio.

Genus PROBOLIUM, Œhlert. 1890.

Dalmanites tridens, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 361, pl. 75, fig. **3.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **4.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **5.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. **6.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Dalmanites nasutus, Conrad (sp.). 1841.

Ann. Rept. Pal. Dept. N. Y., p. 48.

Palæontology of New York, vol. iii, 1859, pl. 75, fig. 2.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 1.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 2.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, fig. 3.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, figs. 4, 5, 6.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard, purchase.

Palæontology of New York, vol. iii, 1859, pl. 76, figs. 7, 8.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Genus ODONTOCEPHALUS. Conrad. 1840.

Dalmanites selenurus, Eaton (sp.). 1832.

Geol. Text-book, p. 31, pl. 1, fig. 1

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 15.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11b, figs. 16, 17.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. ii, 1888, pl. 11b, fig. 18.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 19.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 21.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, figs. 5, 6.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, fig. 7.
Corniferous limestone. Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 12, 13; and Palæontology of New York, vol. vii, 1888, pl. 12, figs. 8, 9.
Corniferous limessone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 1, 2; and Palæontology of New York, vol. vii, 1888, pl. 12, figs. 10, 11.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 12, fig. 12.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1885.

Dalmanites Ægeria, Hall. 1861.

Descr. New Species Fossils, etc., p. 57.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 5.
Corniferous limestone. Williamsville, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York. vol. vii, 1888, pl. 11b, fig. 10.
Corniferous limestone. Clarence, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 11.
Corniferous limestone. Clarence, N. Y.
Collected by J. M. Clarke, 1885.

Dalmanites bifidus, Hall. 1861.

Descr. New Species Fossils, p. 63.

Palæontology of New York, vol. vii, 1888, pl. 11b, figs. **2, 3.**
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, plate 11b, figs. **24, 25.**
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1886.

Genus CORYCEPHALUS, Hall. 1888.

Dalmanites pygmæus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p, 56, pl. 11, figs. **5, 6.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 11, figs. **7, 8.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Dalmanites dentatus, Barrett. 1876.
Amer. Journ. Science, vol. ii, 3d ser., p. 200.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 5.
Lower Helderberg group. Port Jervis, N. Y.
Collected by J. W. Hall, 1877.

Palæontology of New York, vol. vii. 1888, pl. 11a, fig. 6.
Lower Helderberg group. Port Jervis, N. Y.
Collected by J. W. Hall, 1877.

Genus CRYPHÆUS, Green. 1837.

Dalmanites Boothi, Green (sp.). 1837.
Amer. Journ. Science, vol. 32, p. 343.
(? *Calymene microps*, Green. 1832.)

(*) Monograph of the Trilobites of North America, page 34, Cast No. **6.**
Said to be from a black limestone at Ripley, Ohio.
The Albany Institute donor.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, figs. 1, 2; and Palæontology of New York, vol. vii, 1888, pl. 16, figs. 1, 2, pl. 16a, fig. 8.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 5; and Palæontology of New York, pl. 16, fig. 3.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 6; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 4.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 14; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 4.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 5.
Hamilton group. Geneseo, N. Y.
Collected by C. A. White and C. Van Delo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 10; and Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 6.
Hamilton group. Geneseo, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig 12; and Paleontology of New York, vol. vii, 1888, pl. 16a, fig. 7.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Dalmanites Boothi, var. *calliteles*, Green, (sp.). 1837.
Amer. Journ. Science, vol. xxxii, p. 346.
Palæontology of New York, vol. vii, 1888, pl. 16, fig. 5; 16a, fig. 12.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 6; pl. 16a, fig. 13.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 7; pl. 16a, fig. 14.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 8.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, figs. 3, 4; and Palæontology of New York, pl. 16, figs. 9, 14, 15.
Hamilton group. Canandaigua Lake, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 10.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, figs. 11, 12.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 13.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 7; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 16.
Hamilton group. Canandaigua, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 16, fig. 8; and Palæontology of New York, vol. vii, 1888, pl. 16, fig. 17.
Hamilton group. Canandaigua, N. Y.
Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 16, figs. 19, 20, 21.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16, fig. 22.
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, pl. 16a, fig. 10.
Tully limestone. Goodwin's, Cayuga Lake, N. Y.
Donated by S. G. Williams.

Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 15.
Hamilton group. Hopewell, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16a, fig. 16.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Journal of Morphology, vol. ii, 1888, pl. 21, fig. 22.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Dalmanites comis, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 41, pl. 16a, fig. 1.
Upper Helderberg group. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Genus CRYPHINA, Ehlert. 1890.

Dalmanites serrulus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 30, pl. 11a, fig. **12.**
Corniferous limestone. North Cayuga, Ontario.

Genus CORONURA, Hall, 1888.

Dalmanites emarginatus, Hall. 1876.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. **2**; and Palæontology of New York, vol. vii, 1888, pl. 11a, fig. **7.**
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 11a, fig. 8.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Dalmanites aspectans, Conrad (sp.). 1841.
(= *Asaphus diurus*, Green. 1839.)
Fifth Ann. Rept. Pal. N. Y., p. 49, fig. 9.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, figs. 6, 8; and Palæontology of New York, vol. vii, 1888, pl. 13, figs. 3, 4.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 12, fig. 11; and Palæontology of New York, vol. vii, 1888, pl. 13, fig. 5.
Corniferous limestone. Columbus, Ohio.
Collected by R. P. Whitfield, 1865.

Palæontology of New York, vol. vii, pl. 13, fig. 9.
Corniferous limestone. Lime Rock, N. Y.
Collected by J. M. Clarke, 1885.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 10, fig. 1; and Palæontology of New York, vol. vii, pl. 13, fig. 13.
Corniferous limestone. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1865.

Dalmanites myrmecophorus, Green. 1835.
Suppl. Monogr. Tril. North Amer., p. 16.

Palæontology of New York, vol. vii, 1888, pl. 13, fig. 12.
Corniferous limestone. Lime Rock, N. Y.
Collected by J. M. Clarke, 1885.

Palæontology of New York, vol. vii, 1888, pl. 14, fig. 1.
Corniferous limestone. Kingston, N. Y.
Tubbs purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, fig. 15; and Palæontology of New York, vol. vii, 1888, pl. 14, fig. 2.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 13, fig. 16; and Palæontology of New York, vol. vii, 1888, pl. 14, fig. 3.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 14, figs. 4, 5, 6.
(The originals of Conrad's *Asaphus? acantholeurus.*)
Corniferous limestone. "Near Schoharie in limestone with Odontocephalus (Onondaga limestone)."

Palæontology of New York, vol. vii, 1888, pl. 15, figs. 1, 2, 3.
Corniferous limestone. Near Clarksville, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 15, fig. 14.
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Dalmanites coronatus, Hall, 1861.

Descr. New Species Fossils, etc. p. 58.

Palæontology of New York, vol. vii, 1888, pl. 11b, fig. 14.
Corniferous limestone. Schoharie, N. Y.

J. Gebhard purchase.

Family CERAURIDÆ.

Genus CERAURUS, Green. 1832.

Ceraurus pleurexanthemus, Green. 1832.

Monograph of the Trilobites of North America, p. 84, pl. 1, fig. 10; original of cast No. 33.
Trenton limestone. Newport, N. Y.

The Albany Institute donor.

Ceraurus? sp. indet, Hall. 1847.

Palæontology of New York, vol. i, p. 25, pl. iv bis, fig. 20.
Chazy limestone. Chazy, N. Y.

Geological Survey collection.

Family ACIDASPIDÆ.

Genus CERATOCEPHALA, Warder. 1838.

Acidaspis sp. Hall. 1888.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. 14.
Corniferous limestone. Cayuga, Ontario.

Sub-genus ACIDASPIS, Murchison. 1839.

Acidaspis tuberculata, Conrad (sp.) 1840.

Ann. Rept. Pal. Dept., N. Y., p. 205.

Palæontology of New York, vol. iii, 1859, pl. 79, figs. 1, 1a.
Lower Helderberg group. Near Clarksville, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, figs. 3, 5.
Lower Helderberg group. Schoharie county, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 8a.
Lower Helderberg group. Schoharie county, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 12.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1959, pl. 79, fig. 13.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 14.
Lower Helderberg group. Near Clarksville, N. Y.
J. Gebhard purchase.

Acidaspis Trentonensis, Hall. 1847.

("Acidaspis crosotus Locke." J. Gebhard.)

Ninth Annual Report New York State Cabinet of Natural History, pp. 45–47. 1856. Not figured.
Trenton limestone, Cape Vincent, N. Y.
Moses Eames donor.

Sub-genus ODONTOPLEURA, Murchison. 1839.

Acidaspis callicera, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 69, pl. 16b, figs. **1, 2.**
Corniferous limestone. Camillus, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 16b, figs. **3, 4, 5, 6, 7.**
Corniferous limestone. Cayuga, Ontario.
Collected by C. D. Walcott, 1878.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. **9.**
Corniferous limestone. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 16b, fig. **13.**
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Sub-genus DICRANURUS, Conrad. 1841.

Acidaspis hamatus, Conrad (sp.). 1841.

Ann. Rep. Pal. Dept. N. Y., p. 48.

Palæontology of New York, vol. iii, pl. 79, fig. 16.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 17.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 19.
Lower Helderberg group. Albany county, N. Y.

Palæontology of New York, vol. iii, 1859, pl. 79, fig. 19a.
Lower Helderberg group. Schoharie county, N. Y.
J. Gebhard purchase.

Sub-genus ANCYROPYGE, Clarke, 1891.

Acidaspis Romingeri, Hall. 1888.

*Palæontology of New York, vol. vii, 1888, p. 71, pl. 16b, figs. **15, 16, 17, 18.**
Hamilton group. Little Traverse Bay, Michigan.

Family LICHADÆ.

Genus LICHAS, Dalman. 1826.

Sub-genus CONOLICHAS, Dames. 1877.

Lichas pustulosus, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 366, pl. 77, figs. **9, 10.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 77, fig. **11.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebbard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **2.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **3.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **4** (mutilated by having the terminal lobe artifically divided).
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 78, fig. **6**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

* Palæontology of New York, vol. vii, 1888, pl. 19, fig. 8.
Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 10.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 11.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Conolichas? sp., Hall. 1888.

Palæontology of New York, vol. iii, pl. 78, fig. **7** (*Lichas pustulosus*, Hall); and Palæontology of New York, vol. vii, pl. 19, fig. **9**.
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

(?) *Lichas Bigsbyi*, Hall. 1859.

Palæontology of New York, vol. iii, p. 364.

* Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 1.
Lower Helderberg group. Schoharie, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 12.
Lower Helderberg group. Schoharie, N. Y.
J. Gebhard purchase.

(?) *Lichas Eriopis*, Hall. 1863.

Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 226.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, figs. **4, 5, 6, 7**; and Palæontology of New York, vol. vii, 1888, pl. 19a, figs. **2, 3, 4, 5**.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 7.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 8.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. **10**; and Palæontology of New York, vol. vii, 1888, pl. 19a, fig. **9**.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. 12 [*Acidaspis* (*Terataspis*) *sp.*]; and Palæontology of New York, vol. vii, 1888, pl. 19a, fig. 11.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, figs. 13, 15, 16.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1885.

? *Lichas hispidus*, Hall. 1888.

Palæontology of New York, vol. vii, p. 77.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, figs. **8, 9**; and Palæontology of New York, vol. vii, 1888, pl. 19a, figs. **14, 17**.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19a, fig. **18**.
Corniferous limestone. Le Roy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1877.

Sub-genus CERATOLICHAS, Hall. 1888.

Lichas gryps, Hall. 1888.

Palæontology of New York, vol. vii, p. 84.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 19, fig. **1**; and Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **7, 8**.
Corniferous limestone. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **9, 10, 11**.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **12, 12a, 13.**

Corniferous limestone. Canandaigua, N. Y.

Collected by J. M. Clarke, 1886.

Lichas dracon, Hall. 1888.

Palæontology of New York, vol. vii, pl. 85.

Illustrations of Devonian Fossils, pl. 19, figs. **2, 3**; and Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **14, 15.**

Corniferous limestone. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, pl. 19b, figs. **16, 17.**

Corniferous limestone. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **18, 18a.**

Corniferous, limestone. Le Roy, N. Y.

Collected by J. M. Clarke, 1886.

Sub-genus ARGES, Goldfuss. 1839.

Lichas contusus, Hall. 1888.

Palæontology of New York, vol. viii, 1888, p. 83, pl. 19b, fig. **3.**

Corniferous limestone (drift). Canandaigua, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, figs. **4, 5, 6.**

Corniferous limestone. Near Clarksville, N. Y.

Collected by J. W. Hall, 1877.

Sub-genus TERATASPIS, Hall. 1863.

Lichas grandis, Hall. 1861.

Descr. New Species Foss., p. 82.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 17, figs. **1, 2**; and Palæontology of New York, vol. vii, 1888, pl. 17, figs. **2, 3.**

Schoharie grit. Knox, N. Y.

Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 17, figs. **5, 4**; and Palæontology of New York, vol. vii, pl. 17, figs. **4, 5.**

Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 1.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 2.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 18, fig. **4**; and Palæontology of New York, vol. vii, 1888, pl. 19, fig. **5**.
Schoharie grit. Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 6.
Schoharie grit. Knox, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 19, fig. 7.
Schoharie grit. Thompson's Lake, N. Y.
Collected by C. Van Deloo, 1862.

Sub-genus DICRANOGMUS, Corda. 1847.

Lichas ptyonurus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 86, pl. 19b, fig. **19**.
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, fig. **20**.
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 19b, fig. **21**.
Niagara group (Coralline limestone). Schoharie, N. Y.
J. Gebhard purchase.

Family PROETIDÆ.

Genus PROETUS, Steininger. 1831.

Proetus Corycœus, Conrad (sp.) 1842.

Journ. Acad. Nat. Sci., vol. 8, p. 277.

Palæontology of New York, vol. ii, pl. 67, fig. 15.
Niagara group. Lockport, N. Y.

Proetus protuberans, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 351, pl. 73, fig. **5**.
Lower Helderberg group. Schoharie, N. Y.

J. Gebhard purchase.

Proetus angustifrons, Hall. 1861.

Descr. New Species Fossils, p. 70.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 1.
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 2.
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 3.
Schoharie grit. Near Clarksville, N. Y.

J. M. Clarke purchase.

Proetus Conradi, Hall. 1861.

Descr. New Species Fossils, p. 69.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 4.
Schoharie grit. Schoharie, N. Y.

J. Gebhard purchase.

Proetus Hesione, Hall. 1861.

Descr. New Species Fossils, p. 70.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. **15, 16**; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. **15, 16.**
Schoharie grit. Schoharie, N. Y.

Proetus sp., Hall, 1888.

Palæontology of New York, vol. vii, 1888, p. 94, pl. 22, fig. **5**.
Schoharie grit, Schoharie, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **6**.
Schoharie grit. Knox, N. Y.

Collected by C. Van Deloo, **1862,**

Proetus curvimarginatus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 94, pl. 22, fig. **13**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, figs. **14, 15**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, pl. 22, fig. **16**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **17**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, figs. **18, 19**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Proetus latimarginatus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 97, pl. 22, fig. **7**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **8**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **9**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **10**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **11**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **12**.
Schoharie grit. Pendleton, Indiana.
Collected by C. D. Walcott and C. Van Deloo, 1878.

Proetus clarus, Hall. 1861.

Descr. New Species Fossils, p. 71.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **28**.
Corniferous limestone. Decewville, Ontario.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **29**.
Corniferous limestone. Lime Rock, near Le Roy, N. Y.
Collected by J. M. Clarke, 1888.

Proetus folliceps, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 101, pl. 23, figs. **3, 4, 8**.
Corniferous limestone. Near Le Roy, N. Y.
Collected by C. D. Walcott and C. Van Deloo, 1877.

Palæontology of New York, vol. vii, 1888, pl. 23, figs. **6, 7**.
Corniferous limestone (drift). Ann Harbor, Michigan.
Donated by C. Rominger.

Proetus delphinulus, Hall. 1888.

* Palæontology of New York, vol. vii, 1888, p. 111, pl. 23, figs. **1, 2**; pl. 25, fig. **6**.
Corniferous limestone. Port Colborne, Ontario.

Proetus canaliculatus, Hall. 1861.

Descr. New Species Fossils, p. 73.

Palæontology of New York, vol. vii, 1888, pl. 23, figs. 10, 11.
Corniferous limestone. Falls of the Ohio.

Proetus crassimarginatus, Hall. 1843.

Geol. N. Y.; Rept. Fourth Dist., p. 172, fig. 5.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. **20**, fig. **5**; and Palæontology of New York, vol. vii, 1888, pl. 20, fig. 6.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 8, 9; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 7, 8.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, figs. 26, 24; and Palæontology of New York, vol. vii, 1888, pl. 20, figs. 23, 24.
Coniferous limestone. Clarence, N. Y.
Collected by C. A. White, R. P. Whitfield and C. Van Deloo, 1860.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 20, fig. 27; and Palæontology of New York, vol. vii, 1888, pl. 20, fig. 27.
Corniferous limestone. Cayuga, Ontario.
Collected by J. De Cew, 1866.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 20.
Schoharie grit. Near Clarksville, N. Y.
Collected by C. Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. 21.
Schoharie grit. Near Clarksville, N. Y.
Collected by C Van Deloo, 1862.

Palæontology of New York, vol. vii, 1888, pl. 22. fig. 23.
Corniferous limestone. Falls of the Ohio.

Proetus? planimarginatus, Meek. 1871.
Proc. Acad. Nat. Sci. Phil., p. 89.
* Palæontology of New York, vol. vii, 1888, pl. 23, fig. **21**.
Corniferous limestone. Sylvania, Ohio.

Proetus stenopyge, Hall. 1888.
Palæontology of New York, vol. vii, 1888, p. 110, pl. 22, fig. **27**.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1886.

Proetus ovifrons, Hall. 1888.
Palæontology of New York, vol. vii, 1888, p. 110, pl. 22, fig. **31**.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, p. 22, fig. **32**.
Corniferous limestone (drift). Canandaigua, N. Y.
Collected by J. M. Clarke, 1886.

Proetus microgemma, Hall. 1888.
Palæontology of New York, vol. vii, 1888, p. 109, pl. 22, fig. **33**.
Corniferous limestone. Phelps, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 22, fig. **34.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Proetus Rowi, Green (sp.). 1838.
Amer. Journ. Sci., vol. 33, p. 406.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 4; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 4.
Hamilton group. Otsego county, N. Y.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 5; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 5.
Hamilton group. Otsego county, N. Y.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. 24; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. 24.
Tully limestone. Near Ovid, N. Y.
J. Gebhard purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 20.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 22.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 23.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 24.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 25.
Hamilton group (drift). Ann Arbor, Michigan.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 26.
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, figs. 25, 26; and Palæontology of New York, vol. vii, 1888, pl. 21, figs. 25, 26; pl. 23, fig. 27.

Tully linestone. Near Ovid, N. Y.

J. Gebhard purchase.

(*) Palæontology of New York, vol. vii. 1888, pl. 23, fig. 29.

Hamilton group. Centerfield, N. Y.

J. M. Clarke purchase.

Proetus Haldemani, Hall. 1861.

Descr. New Species Fossils, p. 74.

* Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, figs. **7, 8**; and Palæontology of New York, vol. vii, 1888, pl. 21, figs. **7, 8**; pl. 23, fig. **15.**

Hamilton group. Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 13.

Devonian. Rescue Hill, Eureka District, Nevada.

Proetus macrocephalus, Hall. 1861.

Descr. New Species Fossils, p. 77.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **10**; Palæontology of New York, vol. vii, 1888, pl. 21, fig. **10.**

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and C. Van Deloo, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **13**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **13.**

Hamilton group. York, N. Y.

Collected by J. W. Hall and C. Van Deloo, 1866.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **14**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **14.**

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and J. W. Hall, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig **17**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **17.**

Hamilton group. Canandaigua Lake, N. Y.

Collected by R. P. Whitfield and J. W. Hall, 1858.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **18**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **18**.
Hamilton group. Locality?

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 21, fig. **19**; and Palæontology of New York, vol. vii, 1888, pl. 21, fig. **19**.
Hamilton group. North Bristol, N. Y.
Collected by C. A. White and C. Van Dëloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 30.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 23, fig. 31.
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Proetus Prouti, Shumard. 1863.
Trans. St. Louis Acad. Sci., vol. ii, No. 1, p. 110.

(*Proetus Davenportensis*, Barris, 1878, Proc. Davenport Acad. Nat. Sci., vol. ii, p. 287.)
* Palæontology of New York, vol. vii, 1888, pl. 23, figs. **16, 17**.
Hamilton group. Smith's Quarry, Davenport, Iowa.

* Palæontology of New York, vol. vii, 1888, pl. 23, fig. 18
Hamilton group. Cook's Quarry, Davenport, Iowa.

Proetus Phocion, Billings. 1874.
Pal. Foss. Canada, vol. ii, p. 63.

* Palæontology of New York, vol. vii, 1888, pl. 25, fig. **9**.
Hamilton group. Indian Cove, Gaspé, Quebec.

* Palæontology of New York, vol. vii, 1888, pl. 25, fig. **10**.
Hamilton group. Indian Cove, Gaspé, Quebec.

Proetus Nevadæ, Hall. 1888.

* Palæontology of New York, vol. vii, 1888, p. 129, pl. 23, fig. **19**.
Devonian. Comb's Peak, Eureka District, Nevada.

Proetus Missouriensis, Shumard. 1855.
Geol. Rept. Miss., p. 196.

(*Proetus auriculatus*, Hall, 1861. Descr. New Species Fossils, p. 79.)
Palæontology of New York, vol. vii, 1888, pl. 23, fig. **32**.
Waverly group. Licking county, Ohio.

Genus CORDANIA, Clarke. 1893.

Phaëthonides cyclurus, Hall. 1888.

Palæontology of New York, vol. vii, p. 137, pl. 24, figs. **26, 26a.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **27.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Palæntology of New York, vol. vii, 1888, pl. 24, fig. **28.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 25, fig. **11.**
Lower Helderberg group (Shaly limestone). Near Clarksville, N.Y.
J. M. Clarke purchase.

Phaëthonides arenicolus, Hall. 1888.

* Palæontology of New York, vol. vii, 1888, p. 134, pl. 25, fig. **12.**
Schoharie grit. Schoharie, N. Y.

Phaëthonides varicella, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 135, pl. 24, figs. **29, 29a.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. **30, 30a.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **31.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Phaëthonides gemmæus, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 136, pl. 24, fig. **32.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **33.**
Hamilton group. Eighteen-mile Creek, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **34.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **35.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **36.**
Hamilton group. Canandaigua, N. Y.
J. M. Clarke purchase.

Phaëthonides Macrobius, Billings (sp.). 1863.

Proc. Portland Soc. Nat. Hist., p. 128.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 24, 24a.
Lower Helderberg group. Square Lake, Maine.
J. M. Clarke purchase.

Genus CYPHASPIS, Burmeister. 1843.

Cyphaspis cœlebs, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 151, pl. 24, fig. **1.**
Lower Helderberg group (Shaly limestone). Schoharie, N. Y.
J. Gebhard purchase.

Cyphaspis minuscula, Hall (sp.). 1876.

Illustr. Devon. Fossils. Expl. pl. 20, fig. 17.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 7.
Schoharie grit. Near Clarksville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 8, 8a.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 9, 10.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 11.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. 12.
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis stephanophora, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 142, pl. 24, figs. **2, 3.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **4.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **5.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Palæontology of New York. vol. vii, 1888, pl. 24, figs. **6, 6a.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis diadema, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 141, pl. 24, fig. **13.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis hybrida, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 144, pl. 24, fig. **14.**
Corniferous limestone (drift). Canandaigua, N. Y.
J. M. Clarke purchase.

Cyphaspis craspedota, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 148, pl. 24, figs. **15, 16, 17.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. **18, 19.**
Hamilton group. Centerfield, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **20.**
Hamilton group. Centerfield, N. Y.

J. M. Clarke purchase.

Cyphaspis ornata, Hall. 1876.

Illustr. Dev. Foss. Exp., pl. 21, fig. 1.

Palæontology of New York, vol. vii, 1888, pl. 24, figs. 21, 21a.
Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Cyphaspis ornata, var. baccata, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 146, pl. 24, figs. **22, 22a.**
Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 24, fig. **23.**
Hamilton group. Canandaigua, N. Y.

J. M. Clarke purchase.

MEROSTOMATA.

Family EURYPTERIDÆ.

Genus EURYPTERUS, DeKay, 1825.

Eurypterus prominens, Hall. 1888.

(*) Palæontology of New York, vol. vii, 1888, p. 157, pl. 27, figs. **3, 4.**

Clinton group. Northern part of Cayuga county, N. Y.

Eurypterus remipes, DeKay. 1825.

Ann. Lyc. Nat. Hist. N. Y., p. 375.

Palæontology of New York, vol. iii, 1859, pl. 80a, fig. 11.
Waterlime formation. Waterville, N. Y.

J. Gebhard purchase.

Eurypterus lacustris, Harlan. 1834.

Trans. Geol. Soc. Penna., vol. i, p. 98.

Palæontology of New York, vol. iii, 1859, pl. 81, fig. 3.
Waterlime formation. Williamsville, N. Y.

J. Gebhard purchase.

Eurypterus pachycheirus, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 412,* pl. 82,* figs. **1, 1a.**
Waterlime formation. Near Buffalo, N. Y.

J. Gebhard purchase.

Palæontology of New York, vol. iii, 1859, pl. 82,* fig. **3.**
Waterlime formation. Near Buffalo, N. Y.

J. Gebhard purchase.

Eurypterus DeKayi, Hall. 1859.

Palæontology of New York, vol. iii, 1859, p. 411,* pl. 82, fig **1.**
Waterlime formation. Black Rock, N. Y.

J. Gebhard purchase.

Eurypterus Beecheri, Hall. 1884.

Second Geol. Surv. Penna. PPP., p. 80.

* Palæontology of New York, vol. vii, 1888, pl. 27, fig. **5.**
Chemung group. Warren, Pennsylvania.

Eurypterus approximatus, Hall. 1888.

(*) Palæontology of New York, vol. vii, 1888, expl. pl. 27, fig. **6.**
Waverly group. Near Warren, Pennsylvania.

Genus STYLONURUS, Page. 1856.

Stylonurus excelsior, Hall. 1883.

Thirty-sixth Rept. N. Y. State Mus. Nat. Hist., p. 77.

(*) Palæontology of New York, vol. ii, 1888, pl. 26, fig. **1.**
Catskill group. Andes, N. Y.

(*) Palæontology of New York, vol. vii, 1888, pl. 26a, figs. **1, 2, 3** (*Dolichocephala Lacoana*, Claypole, 1883, Proc. Amer. Philos. Soc. vol. xxi, p. 236).
Catskill group. Meshoppen, Pennsylvania.

Stylonurus? (*Echinocaris?*) *Wrightianus*, Dawson.

Quart. Journ. Geol. Soc. vol. xxxvii, p. 301.

(*) Palæontology of New York, vol. vii, 1888, pl. 27, figs. **7, 8, 9.**
Portage group. Italy, N. Y.

PHYLLOCARIDA.

Family CERATIOCARIDÆ.

Genus ECHINOCARIS, Whitfield. 1880.

Echinocaris punctata, Hall. 1863.

Sixteenth Rept. N. Y. State Cab. Nat. Hist., p. 74.

Palæontology of New York, vol. vii, 1888, pl. 27, fig. 10; pl. 28, fig. 4.

Hamilton group. Canandaigua Lake, N. Y.

Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 28, figs. 1, 2; pl. 29, fig. 6.

Hamilton group. Fabius, N. Y.

Collected by G. B. Simpson, 1863.

Palæontology of New York, vol. vii, 1888, pl. 28, fig. 3.

Hamilton group. Pratt's Falls, N. Y.

Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 28, fig. 5.

Hamilton group. Pratt's Falls, N. Y.

Collected by H. H. Smith and C. Van Deloo, 1874.

Sixteenth Report on New York State Cabinet of Natural History, 1863, pl. 1, figs. **1**, **2**; Illustrations of Devonian Fossils, 1876; Crustacea, pl, 23, figs. **4**, **5**; and Palæontology of New York, vol. vii, 1888, pl. 28, figs. **6**, **7**.

Hamilton group. Canandaigua Lake, N. Y.

Collected by C. A. White and C. Van Deloo, 1860.

Palæontology of New York, vol. vii, 1888, pl. 29, figs. 1, 2.

Hamilton group. Pratt's Falls, N. Y.

Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 3.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 4.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 5.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. 7.
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Sixteenth Report on New York State Cabinet of Natural History, 1863, pl. 1, fig. **8**; Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **7**; and Palæontology of New York, vol. vii, 1888, pl. 29, fig. **8**.
Hamilton group. Cayuga Lake, N. Y.
Collected by C. A. White, 1860.

Mandibles of Phyllocarida (Echinocaris punctata).

Palæontology of New York, vol. vii, 1888, pl. 30. fig. **13**.
Hamilton group. Pratt's Falls. N. Y.
Collected by J. W. Hall, 1875.

Palæontology of New York, vol. vii, 1888, pl. 30, fig **14**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **15**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii. 1888, pl. 30, fig. **16**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **17**.
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii. 1888, pl. 30, fig. **18.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **19.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1873.

[?] *Ceratiocaris longicauda,* Hall. 1861.

Sixteenth Report on New York State Cabinet of Natural History, 1861, p. 73, pl. 1, fig. **7** (not figs. 4, 5, 6 = *Coleolus* or *Orthoceras*); and Palæontology of New York, vol. vii, 1888, pl. 31, fig. **1.**
Genesee shales. Bristol Center, N. Y.
Collected by R. P. Whitfield and C. Van Deloo, 1862.

Echinocaris Whitfieldi, Clarke. 1885.
Bull. No. 16. U. S. Geol. Surv. p. 45.

Palæontology of New York, vol. vii, 1888, pl. 29, fig. **20.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **21.**
Naples beds. Naples, N. Y.

[?] *Ceratiocaris Beecheri,* Clarke. 1885.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. **3.**
Naples beds. Sonyea, N. Y.

Echinocaris condylepis, Hall. 1880.

Palæontology of New York, vol. vii, 1888, p. 173, pl. 29, figs. **14, 15.**
Chemung group. Belmont, N. Y.
Collected by Andrew Sherwood, 1871.

Palæontology of New York, vol. vii, 1888, pl. 29, figs. **16, 17.**
Chemung group. Belmont, N. Y.
Collected by Andrew Sherwood, 1871.

Echinocaris socialis, Beecher. 1884.
Second Geol. Surv. Penna., PPP, p. 10.

* Palæontology of New York, vol. vii, 1888, pl. 30, fig. **6.**
Chemung group. Warren, Pennsylvania.

Palæontology of New York, vol. vii, 1888, pl. 30, fig. 7.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

* Palæontology of New York, vol. vii, 1888, pl. 30, fig. **8.**
Chemung group. Warren Pennsylvania.

Palæontology of New York, vol. vii, 1888. pl. 30, fig. 10.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

Echinocaris multinodosa, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 38.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **18.**
Erie shale. Paine's Creek, Ohio.

* Palæontology of New York, vol. vii, 1888, pl. 29, fig. **19.**
Erie shale. Paine's Creek, Ohio.

Echinocaris pustulosa, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 38.

* Palæontology of New York, vol. vii, 1888, pl. 29, figs. **9, 10.**
Erie shale. Paine's Creek, Ohio.

Echinocaris sublævis, Whitfield. 1880.

Amer. Journ. Science, vol. xix, p. 36.

* Palæontology of New York, vol. vii, 1888, pl. 29, figs. **11, 12.**
Erie shale. Paine's Creek, Ohio.

Genus ELYMOCARIS, Beecher. 1884.

Elymocaris capsella, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 181, pl. 31, fig. **4.**
Hamilton group. Canandaigua lake, N. Y.
J. M. Clarke purchase.

Elymocaris siliqua, Beecher. 1884.

Second Geol. Surv. Penna. PPP, p. 13.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **5.**
Chemung group. Warren, Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **6.**
Chemung group. Warren, Pennsylvania.

Genus TROPIDOCARIS, Beecher. 1884.

Tropicodaris Hamiltoniæ. Hall, 1888.

Palæontology of New York, vii, 1888, expl. pl. 30, figs. **24, 25.**
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Tropidocaris interrupta, Beecher. 1884.
Second Geol. Surv. Penna. PPP, p. 18.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **13.**
Chemung group. Warren, Pennsylvania.

Tropidocaris bicarinata, Beecher. 1883.
Second Geol. Surv. Penna. PPP. p. 16.

* Palæontology of New York, vol. vii, 1888, pl. 31, figs. **7, 9.**
Chemung group. Warren, Pennsylvania.

Palæontology of New York, vol. vii, 1888, pl. 31, figs. 8, 10.
Chemung group. Warren, Pennsylvania.
F. A. Randall purchase.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **11.**
Chemung group. Warren, Pennsylvania.

Tropidocaris alternata, Beecher. 1884.
Second Geol. Surv. Penna. PPP. p. 19.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **14.**
Waverly group. Warren, Pennsylvania.

* Palæontology of New York, vol. vii, 1888, pl. 31, fig. **15.**
Waverly group. Warren, Pennsylvania.

Family RHINOCARIDÆ.

Genus RHINOCARIS, Clarke. 1888.

Rhinocaris columbina, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 196, pl. 31, figs. **16, 17.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by J. M. Clarke, 1886.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **18.**
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **19.**
Hamilton group. Cayuga Lake, N. Y.
Collected by H. H. Smith, 1871.

Palæontology of New York, vol. vii, 1888, pl. 31, fig. **20.**
Hamilton group. Canandaigua Lake, N. Y.
J. M. Clarke purchase.

Rhinocaris scaphoptera, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 197, pl. 31, figs. **22, 23.**
Hamilton group. Canandaigua Lake, N. Y.
Collected by J. M. Clarke, 1886.

Genus MESOTHYRA, Hall. 1888.

Mesothyra Veneris, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 193, pl. 33, fig. **3.**
Marcellus shale. East Bloomfield, N. Y.
J. M. Clarke purchase.

Mesothyra Neptuni, Hall. 1863.

Sixteenth Report on New York State Cabinet of Natural History, 1863, p. 75, pl. 1, fig. **9**; Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **6**; and Palæontology of New York, vol. vii, 1888, pl. 32, fig. **7**; pl. 33, fig. **1.**
Hamilton group. Plainfield, N. Y.
J. Gebhard purchase.

Mesothyra spumæa, Hall. 1888.

Palæontology of New York, vol. vii, 1888, p. 93, pl. 32, figs. **8, 9.**
Hamilton group. Delphi, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1875.

Palæontology of New York, vol. vii, 1888, pl. 33, fig. **2.**
Hamilton group. Pratt's Falls, N. Y.
Collected by H. H. Smith and C. Van Deloo, 1874.

Mesothyra Oceani, Hall. 1888.

Pal. N. Y., vol. vii, p. 187.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **1**; Palæontology of New York, vol. vii, 1888, pl. 32, fig. **3**; pl. 33, fig. **5.**
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **2**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **2**.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **3**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **1**.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **4**; and Palæontology of New York, vol. vii, 1888, pl. 32, fig. **5**; pl. 34, fig. **4**.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **5**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **3**.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **1**; and Palæontology of New York, vol. vii, 1888, pl. 33, fig. **6**.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23; fig. **2**; and Palæontology of New York, vol. vii, 1888, pl. 33, fig. **7**.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Illustrations of Devonian Fossils, 1876; Crustacea, pl. 23, fig. **3**; and Palæontology of New York, vol. vii, 1888, pl. 34, fig. **5**.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Palæontology of New York, vol. vii, 1888, pl. 32, figs. 1, 2, 4, 6; pl. 33, fig. 4.
Portage group. Ithaca, N. Y.
Collected by J. W. Hall and G. B. Simpson, 1870.

Family DISCINOCARIDÆ.

[?] Genus SPATHIOCARIS, Clarke. 1882.

Spathiocaris Emersoni, Clarke. 1882.

Amer. Journ. Science, 3d Ser., vol. 23, p. 447.

Palæontology of New York, vol. vii, 1888; pl. 35, fig. **12.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 13.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 14.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **15.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 16.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **17.**
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 18.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. 19.
Naples beds. Naples, N. Y.
J. M. Clarke purchase.

(?) Genus DIPTEROCARIS, Clarke. 1883.

Dipterocaris pes-cervæ, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. 25, p. 128.

Palæontology of New York, vol. vii, 1888, pl. 35, figs, **20, 21.**
Chemung group. Dansville, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. 22, 23.
Naples beds. Naples, N. Y.

J. M. Clarke purchase.

Dipterocaris pennæ-Dædali, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. xxv, p. 122.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **24**.
Portage group. Canadice, N. Y.

J. M. Clarke purchase.

Dipterocaris Procne, Clarke. 1883.

Amer. Journ. Science, 3d ser., vol. xxv, p. 122.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **25**.
Portage group. Canadice, N. Y.

J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **26, 27**.
Chemung group. Haskinsville, N. Y.

J. M. Clarke purchase.

PHYLLOPODA.

Family LIMNIADIADÆ.

Genus ESTHERIA, Ruppell.

Estheria pulex, Clarke. 1882.

Amer. Journ. Science, vol. 23, p. 476.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **10, 11.**
Hamilton group. Hopewell, N. Y.
J. M. Clarke purchase.

Genus SCHIZODISCUS, Clarke.

Schizodiscus capsa, Clarke. 1888.

Palæontology of New York, vol. vii, 1888, p. 209, pl. 35, figs. **1, 2.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **3, 4.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **5.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **6.**
Hamilton group. Centerfield, N. Y.
J. M. Clark purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, figs. **7, 8.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

Palæontology of New York, vol. vii, 1888, pl. 35, fig. **9.**
Hamilton group. Centerfield, N. Y.
J. M. Clarke purchase.

DECAPODA.

Family CARIDIDÆ.

Genus PALÆOPALÆMON, Whitfield. 1880.

Palæopalæmon Newberryi, Whitfield. 1880.

Amer. Jour. Science, vol. 19, p. 41.

* Palæontology of New York, vol. vii, 1888, pl. 30, figs. **20, 21, 22, 23.**

Erie shale. Le Roy, Ohio.

Summary.

CRUSTACEA.

Total original specimens	248
Total illustrated specimens	496
Total casts of original specimens	50
Total figures of these specimens	742

Record of Localities of Extra Limital Geological and Palæontological Collections of the New York State Museum.

[Specimens marked with round orange-colored tickets.]

No. 157. Clinton group. Hamilton, Ontario, Canada. C. D. Walcott collector. 1878.

No. 180. Niagara shale. Waldron, Shelby county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 181. Niagara limestone. Charlestown, Clark county, Indiana. C. D. Walcott, collector. 1878.

No. 182. Niagara limestone. Flat Rock creek, Shelby county, Indiana. C. D. Walcott, collector. 1878.

No. 183. Niagara limestone. Hamilton, Ontario, Canada. C. D. Walcott, collector. 1878.

No. 255. Sandstone, =Schoharie grit. Pendleton, Madison county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 278. Corniferous limestone. Charlestown, Clarke county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 278a. Corniferous limestone. Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 279. Corniferous limestone. Falls of the Ohio. From Sidney Lyon.

No. 279a. Corniferous limestone. Falls of the Ohio. C. D. Walcott, collector. 1877.

No. 280. Corniferous limestone. South Walpole, Ontario, Canada, 4th Con. Lot 14. C. D. Walcott, collector. 1878.

No. 281. Corniferous limestone. North Walpole, Ontario, Canada. 13 Con. Lot 5. C. D. Walcott, collector. 1878.

No. 282. Corniferous limestone. South Cayuga. 4th Con. Lots 30 and 32. C. D. Walcott, collector. 1878.

No. 283. Corniferous limestone. Pt. Colborne and Wainfleet, Ontario, Canada. 1 and 2 Con. C. D. Walcott, collector. 1878.

No. 284. Corniferous limestone. Kelly's Island and on Pt. Marble Head, Ohio. C. D. Walcott, collector. 1878.

No. 300. Hamilton group. Falls of the Ohio and southern Indiana. Sidney Lyon.

No. 301. Hamilton group. Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors. 1878.

No. 324. Hamilton group. Just beneath the Black slate (Genesee). Lexington, Scott county, Indiana. C. D. Walcott, collector.

No. 324a. Hamilton group? Beneath the Waterlime. Lexington, Scott county, Indiana. C. D. Walcott, collector.

No. 326. New Albany Black slate=(Genesee slate of New York). Lexington, Scott county, Indiana. C. D. Walcott and C. Van Deloo, collectors.

No. 350. Carboniferous limestone. Crawfordsville, Indiana. C. D. Walcott, collector. 1877.

On Cordania, a Proposed New Genus of Trilobites.

By JOHN M. CLARKE.

In the Palæontology of New York, volume vii, 1888, certain cephala and pygidia of trilobites from the Upper and Lower Helderberg and Hamilton groups of various localities in the State of New York and elsewhere were tentatively referred to the genus PHAETHONIDES as defined by Angelin. A careful restudy of these fossils and review of the literature pertaining to them, educes the fact that Angelin included under his redefinition of this term PHAETHONIDES, forms which Barrande, the author of the name, never intended to bring into so close association, and which can not be properly regarded as congeneric.

The name PHAETON was introduced by Barrande in 1846* for a genus of trilobites, built on the general plan of PROETUS, but having a dentate pygidium. The type of the group was *Phaeton Archiaci*, from the etage E. This name, however, had been used by Brisson in 1770 for a genus of birds. In 1847, Corda† observed this fact of synonymy and substituted for Barrande's term, the name PRIONOPELTIS. He defined the groups clearly and at length, describing all the parts of the animals, and subdivided his twelve species into two principal groups: A, those with simple, uncarinate cephalic margin; B, those with this margin carinate; and of these groups the first was divided into those (a) with 8 lateral pygidial spines, (b) with 7, (c) with 6 or 5 such spines. An excellent illustration was given of the species *P. Polydorus*, a member of the second division of the first group, though the first species of his typical group is his *P. Priamus*. In the first volume of the "Systeme silurien du Centre de la Boheme," in 1852, Barrande did not formally withdraw his term PHAETON, nor acknowledge its preoccupation. He there retains the term in a subgeneric sense, using it as equivalent to his "Groupe B"

* Notice préliminaire sur le système silurien et les Trilobités de Bohême, p. 62.

† Prodrom einer Monographie der Böhmischer Trilobiten, p. 122.

of the Proeti, viz.; that having the margin of the pygidium ornamented with spines.

It is evident, however, that Barrande was disposed at this time to relinquish this term, for in the historical introduction to volume i, the name PHAETONIDES appears as equivalent to PHAETON, but without remark or comment.* This is a part of the work which it is fair to assume was prepared after the body of the text was completed. It was not until 1859 that Barrande formally proposed to replace the term PHAETON with PHAETONIDES.† This author also demonstrated, in 1852, that eight of Corda's proposed species of PRIONOPELTIS, including *P. Priamus* and *P. Polydorus*, were synonymous with his (Barrande's) *Phaeton Archiaci*. This last named species, therefore, becomes the type of the genus PRIONOPELTIS, but the generic term, PHAETON, Barrande, has not the least title to recognition.‡

Angelin, in 1854 and 1878,§ had adopted the term PHAETHONIDES (with this spelling), quoting Barrande as the authority for the name, but including under it not only species with a dentate pygidium, but also those in which the pygidial margin is entire; the only species described by him being one of the latter class, *Asaphus Stokesi*, Murchison. This author's conception of the genus was in one sense essentially equivalent to that of Corda's interpretation of PRIONOPELTIS, since the forms included by the latter in his group B (*P. Ascanius*, *P. Astyanax*) have been proved to possess pygidia with entire margins, and Novák has separated them under the name, TROPIDOCORYPHE (type, *Proetus filicostatus*, Novák). The fossils referred to PHAETHONIDES, Angelin, in the volume of the Palæontology of New York already cited, agree with that author's diagnosis. They all possess entire pygidial margins, though the tubercles with which some are provided, become spinules on the margin and give it the appearance of being dentate. At the same time they are not congeneric with the holopygous species included in Novák's TROPIDOCORYPHE. It is

* Page 42.

† Parallèle entre les dépôts siluriens de Bohême et de Scandinavie, p. 18.

‡ We feel compelled to differ from the opinion recently expressed by the late Dr. Novák in regard to this point (Dames and Kayser's Palæontologische Abhandlungen, Neue Folge, Bnd. 1, p. 11, 1890), who speaks of PRIONOPELTIS as "insufficiently characterized," and considers it better to retain PHAETONIDES. It could be wished that genera were as clearly defined in these days as was this genus of Corda's, 45 years ago

§ Palæontologia Scandinavica, pt. I, p. 21.

evidently necessary to restrict the term PRIONOPELTIS closely to typical forms agreeing with Barrande's *Ph. Archiaci* and *Ph. striatus*, for Novák has also shown good reasons for separating from this association forms like *Phaeton planicauda*, Barrande, and has given to this restricted group the name, PHAETONELLUS.

The American species have a cephalon with a thickened, usually elevated margin, continued into short genal spines. The surface of the ante-lateral limb is concave, the eyes well forward and close together as in CYPHASPIS. The glabella has the form of that in ARETHUSINA, is short, ovoid, has two conspicuous basal lobes, and bears the trace of a pair of short lateral furrows, which are situated at about the mid-length of the glabella, and under favorable circumstances in an internal cast, are seen to bifurcate slightly at their proximal extremities. The number of the thoracic segments has not been ascertained, but specimens found of *Ph. gemmæus*, of the Hamilton group indicate that the number was not more than ten, and that the forms were proetoid in this respect. The pygidium is always relatively large, subsemicircular in outline, the rhachis and pleura abundantly annulated, from 7 to 12, on the former and from 6 to 8 on the latter. The pleural annulations are subequally duplicate. The rhachis does not extend to the margin. The surface is tubercled, the tubercles being irregularly scattered over the cephalon, and arranged in regular rows on the segments and annulations. These tubercles sometimes take the form of spinules (*Ph. arenicolus*, *Ph. gemmæus*) and extend beyond the margin of the pygidium, but they seem never to have their insertion on the margin itself.

This group of trilobites which we propose to term CORDANIA (*Phaethonides cyclurus*, Hall; type), may be said to show alliance to PROETUS in the structure of the pygidium and thorax, to CYPHASPIS in the cephalon generally, and to ARETHUSINA in its glabella in particular. It differs from the TROPIDOCORYPHE of Novák (*Proetus filicostatus*) in the latter having a proetoid, subtriangular glabella, comparatively large and distant eyes, and a pygidium with less conspicuously duplicate annulations and shorter rhachis.

In American faunas this genus is well represented in species, its earliest members being *Cordania cyclura*, Hall (sp.), from the

Lower Helderberg group of New York, and *C. Macrobius*, Billings (sp.), from a similar faunal association at Square Lake, Maine. There is a large undescribed species known to the writer in the Oriskany sandstone of New York; *C. arenicolus*, Hall (sp.), occurs in the Schoharie grit and Corniferous limestone, *C. varicella*, Hall (sp.), in the Corniferous limestone, and *C. gemmæus*, Hall (sp.), in the Corniferous and Hamilton groups. *Asaphus* (*Proetus*) *Stokesi*, Murchison, is probably a member of the same group, and it may be suggested that the pygidium figured by Novák as *Arethusina peltata*, sp. nov., from the Hercynian, possesses a striking similarity to that of CORDANIA.

An interesting species was described by the late Mr. Meek in 1877, from the Devonian of Steptoe Valley, Nevada, under the name, *Proetus* (*Phaeton*) *denticulatus*. The pygidium of this form is short, with a very short, relatively broad rhachis and a row of deep denticulations about the margin. The surface is not otherwise spinous. A glabella found in association with it is distinctly proetoid. Mr. Meek's figures of this fossil were reproduced in the Palæontology of New York, volume vii (pl. XXV, figs. 14, 15), and in the discussion of the species (there referred to PHAETHONIDES (?)), attention was directed to its similarity in form to *Phaeton planicauda*, Barrande, the species since taken by Novák as the type of his PHARTONELLUS. As the latter genus is now defined, *P. denticulatus* is an excellent representative of it.

PRELIMINARY NOTE.

The following paper may seem out of place in the report of the State Geologist, and its presence in this connection may require some explanation. Since the completion of volume IV, Palæontology of New York, I have contemplated the preparation of illustrated catalogues and handbooks in this department, as a part of the museum publications. This subject had received the special attention and consideration of the trustees during several years previous to 1883. Before this time the means of illustration for the museum reports were irregular and uncertain, depending upon the State Printer, whose contracts for printing were not uniform, sometimes providing for lithographic work, and at others we were without such provision. On this account the scientific contributions to the museum reports were irregular and no plan could be made for carrying out such publications as were required of a museum having the objects and purposes as expressed by the law of 1871, chapter 557. When the law of 1883 was framed, this subject entered into the consideration of the trustees, as shown by the following extract:

* * *; "and the trustees of said museum shall be authorized to publish each year the scientific contributions of said staff and such other original scientific contributions as they may deem expedient, which publication shall be in lieu of the reports now required by law from the State Geologist and State Entomologist, and the scientific papers communicated each year to the Legislature along with the annual report of said trustees;" * * * "and by means of printed handbooks describing said collections, and in such other ways as may be practicable, to make said museum a means of instruction to the citizens of the State."

"In order to provide for the expense of printing the aforesaid scientific publications and in order to increase the usefulness and efficiency of said museum as aforesaid, the annual appropriation

to be made for its maintenance shall be fifteen thousand dollars, to be paid on vouchers approved by said trustees."

For the purpose of carrying out this provision of the law the additional sum of $5,000 was added to the previous annual appropriation of the museum. At that time the writer had in preparation and well forwarded a paper upon the genera of the fossil Lamellibranchiata. Also in a forward state of preparation a monograph of the Dictyospongidæ, of which preliminary notices had appeared in the museum reports for 1862 and 1881. The Report for 1862 was published in 1863, and the Report for 1881 was published in 1884; the paper on the Dictyospongidæ having been published in 1882 in advance of the Report. Besides these other papers were in progress corresponding with the subjects uuder investigation for the volumes on the Palæontology.

The monograph upon the Dictyospongidæ, as far as it had progressed, was brought before the Trustees of the State Museum in January, 1885, and the following resolution was passed:

Resolved, That the monograph of Director Hall, on Dictyospongidæ, be published by the museum as Bulletin No. 1.

However, when I asked for the means of completing and publishing the work, it was refused. After the completion of volume V, part I, I brought before the trustees, the subject of a bulletin upon the Genera of Lamellibranchata asking for means of completing the work which had been already carried on to a considerable extent, and ten plates of these illustrations had been already published with my report for 1881. To this application I received a refusal. After this I had in progress and well forwarded, the material for a bulletin upon the Bryozoa, which, at the request of the secretary of the Board of Regents, in 1889, I carried on to near completion at my own expense; but when presented for publication it was refused.

In order to avoid the humiliation of a farther refusal, I have ceased asking for the means of publication, but on several occasions have, brought before the museum committee the drawings of Dictyospongidæ, as far as completed, and also the drawings of fossil Corals, which had been made to the number of at least eighty quarto plates, before the passage of the

law of 1883; on each occasion asking for the consideration of the subject, and the suggestion of some plan for their publication.

The bulletins which have been published under the provisions of the law of 1883, are the following:

"**Volume 1.** 6 *nos. Price,* $1 *in cloth.*

"1 Marshall, W: B. Preliminary list of New York unionidæ. 19 p. Mar. 1892. *Price,* 5 *cents.*

"2 Peck, C: H. Contributions to the botany of the state of New York. 66 p. 2 pl. May 1887. *Price,* 15 *cents.*

"3 Smock, J: C. Building stone in the state of New York. 152 p. Mar. 1888. *Price,* 30 *cents.*

"4 Nason, F. L. Some New York minerals and their localities. 19 p. 1 pl. Aug. 1888. *Price,* 5 *cents.*

"5 Lintner, J. A. White grub of the May beetle. 31 p. il. Nov. 1888. *Price,* 10 *cents.*

"6 Lintner, J. A. Cut-worms. 36 p. il. Nov. 1888. *Price,* 10 *cents.*

"*Price to advance subscribers,* 50 *cents a volume.*

"**Volume 2.** 4 *nos. Price,* $1 *in cloth.*

"The first six bulletins are paged independently; the numbers of v. 2 are paged continuously as a single volume.

"7 Smock, J: C. First report on the iron mines and iron ore districts in the state of New York. 5+70 p. map 58+60 cm. June 1889. *Price,* 20 *cents.*

"8 Peck, C: H. Boleti of the United States. 96 p. Sept. 1889. *Price,* 20 *cents.*

"9 Marshall, W: B. Beaks of unionidæ inhabiting the vicinity of Albany, N. Y. 23 p. 1 pl. Aug. 1890. *Price,* 10 *cents.*

"10 Smock, J: C. Building stone in New York. 210 p. map 58+60 cm. tab. Sept. 1890. *Price,* 40 *cents.*

"11 Merrill, F. J. H. Salt and Gypsum Industries of New York. 89 p. maps. April, 1893. *Price,* 40 *cents.*"

Finding it impossible to obtain publication as I had expected and which had been promised to me before the passage of the law of 1883, I have asked of the Legislature the means of illustrating my annual reports as State Geologist, and the following paper is the first to appear under this authorization. Cer-

tainly such a paper would have been more appropriately published as a bulletin of the State Museum of Natural History, but in this direction publication has been persistently refused.

The preliminary work upon the Genera of Lamellibranchiata has not been continued, and the bulletin in preparation ten years ago remains without material progress. The bulletin on the Bryozoa proposed, and prepared for publication in 1888 and 1889 yet remains unpublished. The work upon the Dictyospongidæ, which was originally recommended to constitute bulletin No. 1 of the museum series, has progressed mainly in the direction of the accumulation of material, and the publication of new species in the report for 1889, until the present year. The continuation of the present paper upon the Brachiopoda is already far advanced and it is expected that it will be published in the annual report of the State Geologist for 1893. The second part will include the spire-bearing genera, the Rhynchonellidæ, Pentameridæ and the Terebratuloids.

With a continuation of the present provisions for illustrating the report of the State Geologist, we may hope within a few years, to retrieve in some measure, the loss of time and publication, suffered during the past ten years.

AN INTRODUCTION

TO THE STUDY OF

THE BRACHIOPODA

INTENDED AS

A HAND BOOK FOR THE USE OF STUDENTS.

By James Hall, assisted by John M. Clarke.

PREFACE.

The accompanying paper has been communicated as a part of and to the report of the State Geologist with the object of presenting to the public an example of the kind of work I had proposed to do under the provisions of the law of 1883, which appropriated the sum of $5,000 annually for the purposes of publishing the "scientific contributions" of the "museum staff and such other scientific contributions as they," the trustees, "may deem expedient; and by means of printed handbooks describing said collections and, in such other ways as may be practicable, to make the said museum a means of instruction to the people of the State."

It had long been my desire to accomplish by some means a diffusion of the knowledge of the Palæontology of the State as a guide and help to students in geology in our colleges and higher schools. In the earlier work of the Palæontology of the State, when the publications were compelled to follow immediately upon the acquisition of fossils from the field, it was necessary to include all the classes of organisms from the formation, or series of formations, under discussion, and, therefore, the earlier volumes present only a very partial attempt at a biological arrangement of the material. As soon as collections had accumulated to such a degree as permitted the treatment of each class of fossils, from one or several formations, in their biological relations they were so discussed and illustrated.

It was not until the time of the publication of the fourth volume upon the Devonian Brachiopoda that such a method of treatment could be adopted, and during this work I became more fully aware than ever before of the necessity of preparing

an epitome or synopsis of that volume, and also including the preceding volumes, so far as related to the brachiopoda, which might bring before the student a clearer appreciation of the generic features of this class of fossils. With this idea in mind arose the conception of treating this subject in the order of geologic time. To one who had worked among the fossils of the older rocks upward through all the formations to the Carboniferous, it was impossible to avoid the conviction that the modification of similar forms in successive geologic periods, and the final disappearance of some of them, either from slow degeneration, or after extravagant manifestations of certain characters, had a significance which had not been fully understood or appreciated by writers upon this class of fossils.

With this conception in mind I began the preparation of what was then intended to be a supplement to Volume IV of the Palæontology of New York. After waiting for more than twenty years for the means of making the necessary collections and for publication, this supplement has expanded into volume VIII, parts i and ii of the Palæontology of New York. From the studies carried forward among the brachiopoda in preparing these volumes has come back to the writer more strongly than ever the importance of preparing a synopsis of the genera which may form a useful handbook for advanced students in geologic studies.

Through the action of an intelligent Legislature and the appreciation of a wise Executive, means have been furnished for making this publication.

The discussions of the genera and their relations are the same as those given in the volumes just named, with corresponding illustrations.

In order to present the subject to the student, in not too abrupt a manner, it has seemed necessary to precede the generic discussions by some general elementary explanations.

There is at present no work in the English language meeting the modern requirements of a guide or introduction to the study of the Brachiopoda in which elementary facts in regard to structure, function, habits and distribution of these animals, the distinguishing characters and systematic relations of their genera, are concisely brought together in one place. The literature pertaining to both recent and fossil forms is widespread and in many languages, beyond the reach of most students, and sometimes accessible with difficulty even to investigators. Dr. Œhlert has admirably summarized the subject in Fischer's Manual de Conchyliologie (1887) and Prof. von Zittel has treated the group still more succinctly in his "Handbuch von Paläontologie." In bringing to a summary the investigations of the palæozoic genera of the brachiopoda as expressed at length in volume VIII, parts i and ii of the Palæontology of New York, it has seemed desirable to present to students an abridgment of the conclusions there derived, with the addition of some introductory and more general descriptive matter. The outcome of this purpose is the present work which it is hoped and believed will be found serviceable to students of both palæontology and geology, and help to nourish the growing interest in the structure and history of these important animals. The work has been prepared for the use of American students to whom it is cordially dedicated.

JAMES HALL,

State Geologist.

THE BRACHIOPODA.

GENERAL CHARACTERS OF THE CLASS.

ı Brachiopoda are marine animals inclosed in bivalved, teral and inequivalved shells.

a group they attained a most prolific and multiform devel- ıt during the Palæozoic and Mesozoic eras in the history of rth, while their existing representatives are comparatively ı number. A knowledge of their variations in form, struct- .d in time is, therefore, of highest importance to the student logy and geology.

›rief, these animals are characterized by the unequal devel- ıt of the two lobes of the cuticular integument (*mantle*), results in the unequal size of the valves. The mouth is ›d subcentrally or posteriorly and is surrounded by elon- usually spiral cirrated expansions, which occupy the ante- ›rtion of the valves and serve as conveyancers of food-bearing currents; in part, also, subserving the function of respira- There is a simple œsophageal nerve-ring with an inferior ›-œsophageal ganglion, and various small accessory nerve-

The sexes are distinct in all species in which these ːters have been studied.

ıts of Life. From our knowledge of existing species it is ›d that all Brachiopoda, at some period of their existence, ːached to extraneous objects. To this statement, there is ıe known exception among living forms, namely, the lin- , *Glottidia Audebardi.* In the fossil (Palæozoic) genera ›ops and Pseudocrania there is no evidence of attachment kind, either in the young condition (Phol idops), or in the ɜ and senile stages of growth.

ıtion is usually effected by means of a fleshy arm or pedicle ıter or less length, protruded through an aperture at, or near

Davidson, Palæont. Soc. Vol. III, 1853.
Introduction to the Study of Brachiopoda, with
Notes by Owen & Carpenter on the Anatomy

the apex of the larger valve. In certain genera, however, fixation is attained by the cementation of the lower valve (CRANIA), or of the umbonal portion of the larger valve (STROPHALOSIA, DAVIDSONIA, LEPTÆNISCA, CHONOPECTUS, etc.) to the external object.

FIG. 1.—*Derbya Bennetti.* An adult example in which the scar of attachment (*x*) is retained. A *Crania* is attached to the umbo of the brachial valve.

The former mode of attachment takes place at an early stage in the growth of the animal, and is continued in some instances throughout the remainder of its life (TEREBRATELLA, MAGELLANIA, HEMITHYRIS, etc.); at other times the pedicle becomes atrophied after adolescence or maturity, by the incurvature of the beak of

FIG. 2.—A portion of the inner surface of a brachial valve of *Productus*, to which a number of very young shells of *Derbya* are attached by the cementation of the pedicle-valve. It will be observed that most of the attached shells have the hinge line parallel to that of the *Productus*, though their relative positions are inverted.

the larger valve, or by the closing of the aperture for its passage by adventitious deposits of calcareous matter, and the shell thus becomes free. This condition is true of some living genera, while it obtained among the majority of Palæozoic species,

ly those of the genera STROPHOMENA, RAFINESQUINA,* STRO-ITA, LEPTÆNA, PLECTAMBONITES, CHONETES, PRODUCTUS, etc. *ion by calcareous cementation* also began early in life, and IA, DAVIDSONIA, LEPTÆNISCA and RICHTHOFENIA, continues the remainder of the animal's existence, the attached equently being fixed by its entire outer surface. In other the condition of attachment was restricted to early, or ent growth stages; (ORTHOTHETES, DERBYA, STROPHALOSIA, INA, etc.),† the shell in after life becoming detached from ring, but usually retaining a scar or deformation of the in the umbonal region. Attachment by cementation has own by JACKSON to induce among the Lamellibranchiates gly vesicular structure in the attached shell; and it may

ragment of a crinoid column cov- a number of individuals of *Crania* which retain the marks of the etween the segments of the crinoid

FIG. 4.—Lower valves of *Crania quadrata* attached to column of a crinoid, the upper valves having been removed by natural causes (DAVIDSON).

le of more general application, as it is seen in certain d annelidan tubes, e. g., *Cornulites proprius;* and among rachiopods which are attached by a considerable surface shell, such as CRANIA and, especially, the extravagant OFENIA, the vesciculation of the shell-structure is a striking

requently in STROPHOMENA and RAFINESQUINA a minute pedicle-passage is retained in e condition of the shell, but it is always evident that the shell could not, at this rowth, have been supported by any muscular apparatus which might be protruded is aperture. In *Rafinesquina alternata*, of the Lower Silurian, it is seen that the n of the aperture has increased most rapidly about the base of the pedicle, and the ening of the passage may be altogether closed, while the external opening remains. *Lu Ulrichi*, of the Lower Silurian, is the only inarticulate brachiopod which appears en thus attached in early growth and to have become free at maturity.

Glottidia Audebardi has been mentioned as a species in which attachment exists at no stage of development. The muscular pedicle of the animal penetrates marine sediments and gathers about itself a mass of agglutinated grains of sand, fragments of shell and bits of sea-weed, forming thus a distinctly free capsule or tube, after the manner of many worms. This may be regarded as a sort of attachment, as the animal, after the formation of this tube, is at no time free from it.

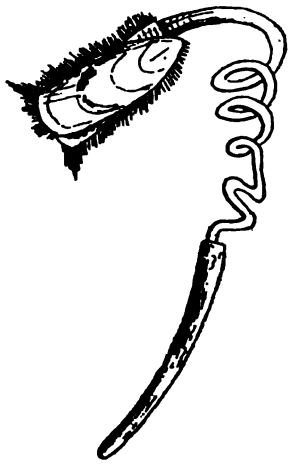

FIG 5 — *Glottidia Audebardi* (MORSE).

In the genus STROPHALOSIA, the attachment by the substance of the valve was frequently aided by the long spines with which the attached valve is furnished, these adhering to, or embracing the foreign object. An individual of *Strophalosia radicans*, having become lodged in the cavity between the calyces of a compound coral (*Acervularia*), has anchored itself essentially by its spines alone, only the posterior edge of the valve coming into contact with its host.

FIG. 6 — *Strophalosia radicans*, situated in a cavity between the calyces of *Acervularia*, and attached by its spines. X 3.

ETHERIDGE has described some small productoids (*Etheridgina complectens*), which are attached to columns of crinoids by the encircling of the spines, as though at some time these spines had been flexible and prehensile organs. The same author

also mentions a species of CHONETES apparently attached by the spines on the cardinal margin, but this observation seems to require verification. *Productella navicella*, of the Devonian, has the spines in the umbonal region of the large valve curved upward, those from opposite sides passing each other; like a man's arms extended and folded above his head. These were undoubtedly clasping or anchoring spines.

It is even possible that *fixation by mooring*, or temporary attachment was effected by an extravagant growth and enfolding of the anterior portions of the larger valve, in some Carboniferous productoids (PROBOSCIDELLA) which have been described by DE VERNEUIL, DE KONINCK, DAVIDSON and others.

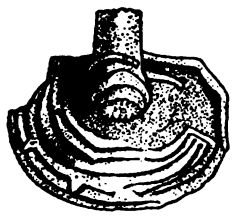

FIG 7.— *Etheridgina complectens* attached by its spines to a crinoid column. (ETHERIDGE.)

FIG. 8 — *Productella navicella*, showing the clasping spines in the umbonal region Hamilton group; New York.

The capability of locomotion in the brachiopods was very limited. During the unattached condition the spawn were active swimmers. TEREBRATULINA becomes attached very early in its history, while DISCINSCA is fixed only after many of the adult characters have been assumed. It is difficult to believe that any power of locomotion was possessed by the ancient forms in which the pedicle was atrophied at maturity and the shell thus set free, as SPIRIFER, PRODUCTUS, some forms of ATHYRIS, etc.; or that the animals could depend on other than circumstantial causes for a change of place. Some writers have suggested that the long spines with which several genera, especially PRODUCTUS, are furnished, may have been aids to such motion, but as these spines were unquestionably rigid bodies, it is difficult to believe that they could have had any part in the voluntary motion of the animal.

DISTRIBUTION. The brachipods are gregarious in habit and over a given area of the sea-bottom a single species will frequently be found in great numbers. "Prof. JUKES got immense numbers of *Waldheimia flavescens* or *australis* while boating in Australia

among the reefs. M. Vélain picked up a small species of KRAUSSINA in vast numbers on the shore in the interior crater of the island of St. Paul, the shells being alternately covered with water and left dry at every tide. *Kraussina rubra*, from the coast of Natal in South Africa, was described by Dr. Gray as having been found attached in great numbers to Ascidia and stems of seaweeds" (DAVIDSON). It is said that more than twenty bushels of *Lingula anatina* were picked up after a violent storm on the coast of Manilla, and EHLERT states that on the coast near Guernsey were found at one time about two hundred specimens of *Cistella cistellula*.

Some of the genera and species of brachiopods possess remarkable power of resistance to physical conditions, and are found at various depths. The genus DISCINISCA has representatives within five fathoms of the surface and at a depth of 2,500 fathoms; the species *Terebratulina caput-serpentis* ranges from near the surface to a depth of 1,195 fathoms. The greatest depth from which any species has been dredged is 2,945 fathoms (*Liothyrina Wyvillii*).

The evidence afforded by living species is as yet insufficient to determine the effects of bathymetric conditions upon specific characters. It is evident that different species are variously affected or inequably resistant to these influences; but as a general rule, different species or associations of species are found at different depths.

In the summary of bathymetric distribution of living species as given by EHLERT, it appears that in the *Littoral Zone*, or that between tides, there are 17 known species, 7 of which are peculiar to it; in the *Laminarian Zone* (to a depth of 15 fathoms), there are 46 species, 15 of which are peculiar to it; in the *Zone of Nullipores* (from 15 to 50 fathoms) are 39 species, of which but 3 are restricted to it; in the *Zone of Brachiopods* (from 50 to 278 fathoms), 58 species have been found, and 20 of these are not known elsewhere; in the *Abyssal Zone* (from 278 to 2,945 fathoms) have been found 30 species, of which 12 do not occur elsewhere. It is, however, to be observed that in these conventional divisions the so-called restricted species occur either in zones of great vertical extent or those where organic life generally is the most prolific. There is no evidence that this bathymetric range of the brachiopods has been effected by any other

causes than restricted powers of self-distribution, in co-operation with a given capacity of resistance to physical forces.

An important factor in their distribution is the influence of heat and cold, to which the brachiopods are evidently sensitive; a fact which makes itself apparent in their geographical dissemination. There are some species (*Hemithyris psittacea*, *Liothyrina arctica*, *Terebratella Spitzbergensis*) which flourish best in the cold waters about the north pole, and never transgress into the warmer seas where the brachiopods are most prolific. At the same time there are a few species that are world-wide in their distribution (*Liothyrina vitrea*, var. *minor*, *Terebratulina caput-serpentis*), and, as EHLERT observes, these are species which also possess the greatest bathymetric range.

The following table of the *Geographical Provinces* and the species embraced within them has been largely drawn from that compiled by EHLERT in FISCHER'S *Manuel de Conchyliologie*. This may be studied in connection with the accompanying map of the World, upon which is plotted the distribution of living species.

ARCTIC PROVINCE:

Atretia gnomon.
Crania anomala.
Discinisca atlantica.
Liothyrina arctica.
Macandrevia cranium.
Dallina septigera.
Magellania tenera.
Rhynchonella (Hemithyris) psittacea.
Terebratalia frontalis.
Terebratella Spitzbergensis.
Terebratulina caput-serpentis.

BOREAL PROVINCE:

Atretia gnomon.
Cistella cistellula.
Crania anomala.
" " var. *alba.*
Laqueus Californicus (Megerlina Jeffreysi.)
Macandrevia cranium.
Dallina septigera.
Rhynchonella (Hemithyris) psittacea.
Terebratella Frielii.
T. Labradorensis.
T. Spitzbergensis.
Terebratalia transversa.
T. rebratulina caput-serpentis.
T. unguiculata.

LUSITANIAN PROVINCE:

Cistella cistellula.
C. cuneata.
C. neapolitana.
Crania anomala.
Discina striata.
Discinisca atlantica.
Eucalathis ergastica.
E. Murrayi.
E. tuberata.
" " var. *mediterranea.*
Gwynia capsula.
Liothyrina sphenoidea.
L. vitrea.
" " var. *minor.*
Macandrevia cranium.
Dallina septigera.
Megathyris decollata.
Mühlfeldtia truncata.
" " var. *monstruosa.*
Platidia anomoides.
P. Davidsoni.

Platidia lunifera.
Rhynchonella (Hemithyris) cornea.
Terebratulina caput-serpentis.
T. trigona.

WEST AFRICAN PROVINCE:

Dyscolia Wyvilii.
Discina striata.
Lingula parva.
Liothyrina sphenoides.
Mühlfeldtia incerta.
Rhynchonella (Hemithyris) cornea.
Terebratulina caput-serpentis.

SOUTH AFRICAN PROVINCE:

Agulhasia Davidsoni.
Kraussina cognata.
K. Davidsoni.
K. pisum.
K. rubra.
Liothyrina vitrea, var. *minor.*

INDO-PACIFIC PROVINCE:

Discinisca stella.
Lingula affinis.
L. anatina.
L. hians.
L. hirundo.
L. Reevii.
Liothyrina vitrea, var *minor.*
Mühlfeldtia sanguinea.
M. truncata.
Rhynchonella (Hemithyris) Grayi.
Terebratella Frielii.
Terebratulina Cumingi.
T. japonica.
T. Murrayi.

AUSTRALO-ZEALANDIAN PROVINCE:

Crania Suessi.
Kraussina Atkinsoni.
K. Lamarckiana.
Lingula exusta.
L. Murphiana.
L. tumidula.
Liothyrina Wyvillii.
Magasella Evansi.
M. fibula.
M. inconspicua
Magellania flavescens
M. lenticularis.
Mühlfeldtia truncata.
M. Willemoesi.
Rhynchonella (Hemithyris) nigricans
Terebratella cruenta.
T. rubicunda.
Terebratulina cancellata.

JAPANESE PROVINCE:

Crania japonica.
Discinisca stella.
Laqueus pictus.
L. rubella.
Lingula Adamsi.
L. jaspidea.
L. lepidula.
L. smaragdina.
Liothyrina Dalli.
L. vitrea var. *Davidsoni.*
Macandrevia cranium.
Magasella Adamsi.
M. Gouldi.
Magellania Grayi.
Dallina Raphaelis.
Mühlfeldtia sanguinea.
Rhynchonella (Hemithyris) Dülerlein
R. lucida.
R. psittacea.
Terebratalia coreanica.
T. frontalis.
Terebratella Mariæ.
T. Spitzbergensis.
Terebratulina caput-serpentis.
T. Crossii.
T. Cumingi.
T. japonica.
T. radiata.

ALEUTIAN PROVINCE:

Magasella aleutica.
M. radiata.
Rhynchonella (Hemthyis) psittacea.
Terebratalia frontalis.
Terebratella Lamanoni.
T. transversa.
Terebratulina unguiculata.

CALIFORNIAN PROVINCE:

Glottidia albida.
G. Palmeri.
Laqueus californicus.

Liothyrina Stearnsi.
Platidia anomoides.
Terebratalia obsoleta.
T. occidentalis.
Terebratella transversa.
Terebratulina unguiculata.

PANAMIC PROVINCE:

Discinisca Cumingi.
D. lamellosa.
Glottidia Audebardi.
G. semen.
Liothyrina uva.

PERUVIAN PROVINCE:

Discinisca Cumingi.
D. lævis.
D. lamellosa.
Liothyrina Wyvillii.
Magellania Wyvillii.
Terebratalia dorsata.

MAGELLANIAN PROVINCE:

Liothyrina Moseleyi.
L. Wyvillii.
Magasella flexuosa.
M. lævis.
M. rhombea.
Magellania Kerguelenensis.
M. venosa.
Platidia anomoides.
Rhynchonella (Hemithyris) nigricans.
Terebratalia dorsata.
Terebratella pulvinata.
Terebratulina Murrayi.
T. septentrionalis.

PATAGONIAN PROVINCE:

Liothyrina uva.

CARIBBEAN PROVINCE:

Bouchardia rosea.
Cistella Barrettiana.
C. lutea.
C. Schrammi.
C. Schrammi var. *rubrotincta.*
Crania Pourtalesi.
Discinisca Antillarum
D. Cumingi.
Discolia Wyvillii.
Glottidia Antillarum.
G. pyramidata.
Liothyrina Bartletti.
L. incerta.
L. Moseleyi.
Platidia anomoides.
Terebratulina Cailleti.
T. caput-serpentis.
Thecidium mediterraneum.

TRANSATLANTIC PROVINCE:

Crania Pourtalesi.
Discinisca atlantica.
Glottidia pyramidata.
Dallina floridana.
Platidia anomoides.
Terebratulina Cailleti.
T. septentrionalis.

EXPLANATION OF MAP.

The geographical position of each species is represented by a black circle inclosing a number, which refers to the following alphabetical list of names:

(The fact is recognized that some of the names here employed probably represent developmental phases of other species, but as it is impossible with our present knowledge to ascertain of how many such names this is true, the commonly accepted designations are therefore employed.)

1. Agulhasia Davidsoni.
2. Atretia Brazieri.
3. A. gnomon.
4. Bouchardia rosea.
5. Cistella Barrettiana.
6. C. cistellula.
7. C. cuneata.
8. C. Kowalevskii.
9. C. lunifera.
10. C. lutea.
11. C. neapolitana.
12. C. Schrammi.
13. " " var. rubrotincta.
14. C. Woodwardiana.
15. Crania anomala.
16. " " var. alba.
17. C. japonica.
18. C. Pourtalesi.
19. C. Suessi.
20. C. turbinata.
21. Discina striata.
22. Discinisca Antillarum.
23. D. atlantica.
24. D. Cumingi.
25. D. lævis.
26. D. lamellosa.
27. D. stella.
28. Dysmolia Wyvillii.
29. Eucalathis ergastica.
30. E. Murrayi.
31. E. tuberata.
32. " " var. mediterranea.
33. Glottidia albida.
34. G. Antillarum.
35. G. Audebardi.
36. G. Palmeri.
37. G. pyramidata.
38. G. semen.
39. Gwynia capsula.
40. Kraussina Atkinsoni.
41. K. cognata.
42. K. Davidsoni.
43. K. Deshayesi.
44. K. Lamarckiana.
45. K. pisum.
46. K. rubra.
47. Laqueus californicus.
48. " " var. Vancouverensis.
49. L. pictus.
50. Lingula Adamsi.
51. L. affinis.
52. L. anatina.
53. L. exusta.
54. L. hians.
55. L. hirundo.
56. L. jaspidea.
57. L. lepidula.
58. L. Murphiana.
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60. L. Reevii.
61. L. smaragdina.
62. L. tumidula.
63. Liothyrina arctica.

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EXPLANATION OF MAP.

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(The fact is recognized that some of the names here employed probably represent developmental phases of other species, but as it is impossible with our present knowledge to ascertain of how many such names this is true, the commonly accepted designations are therefore employed.)

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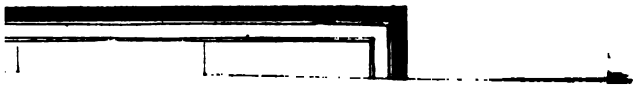
7. C. cuneata.
8. C. Kowalevskii.
9. C. lunifera.
10. C. lutea.
11. C. neapolitana.
12. C. Schrammi.
13. " " var. rubrotincta.
14. C. Woodwardiana.
15. Crania anomala.
16. " " var. alba.
17. C. japonica.
18. C. Pourtalesi.
19. C. Suessi.
20. C. turbinata.
21. Discina striata.
22. Discinisca Antillarum.
23. D. atlantica.
24. D. Cumingi.
25. D. laevis.
26. D. lamellosa.
27. D. stella.
28. Dysnomia Wyvillii.
29. Eucalathis ergastica.
30. E. Murrayi.
31. E. tuberata.
32. " " var. mediterranea.
33. Glottidia albida.
34. G. Antillarum.
35. G. Audebardi.
36. G. Palmeri.
37. G. pyramidata.
38. G. semen.
39. Gwynia capsula.
40. Kraussina Atkinsoni.
41. K. cognata.
42. K. Davidsoni.
43. K. Deshayesi.
44. K. Lamarckiana.
45. K. pisum.
46. K. rubra.
47. Laqueus californicus.
48. " " var. Vancouverensis.
49. L. pictus.
50. Lingula Adamsi.
51. L. affinis.
52. L. anatina.
53. L. exusta.
54. L. hians.
55. L. hirundo.
56. L. jaspidea.
57. L. lepidula.
58. L. Murphiana.
59. L. parva.
60. L. Reevii.
61. L. smaragdina.
62. L. tumidula.
63. Liothyrina arctica.



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7. C. cunea
8. C. Kowa
9. C. lunife
10. C. lutea.
11. C. neapo
12. C. Schra
13. " "
14. C. Wood
15. Crania anoma
16. " "
17. C. japonic
18. C. Pourtal
19. C. Suessi.
20. C. turbina
21. Discina striata.
22. Discinisca Anti
23. D. atla
24. D. Cun
25. D. lævi
26. D. lam
27. D. stell
28. Dysnolia Wyvi
29. Eucalathis erg
30. E. Mu
31. E. tub
32. " "

64. Liothyrina sphenoidea.
65. L. subquadrata.
66. L. vitrea.
67. " " var. cernica.
68. " " " Davidsoni.
69. " " " minor.
70. L. Wyvillii.
71. Macandrevia cranium.
72. Magasella Adamsi.
73. M. aleutica.
74. M. crenulata.
75. M. Evansi.
76. M. fibula.
77. M. flexuosa.
78. M. Gouldi.
79. M. incerta.
80. M. inconspicua.
81. M. Labradorensis.
82. M. lævis.
83. M. patagonica.
84. M. radiata.
85. M. rhombea.
86. Magellania flavescens.
87. M. (Dallina) floridana.
88. M. (Dallina) Grayi.
89. M. Kerguelenensis.
90. M. lenticularis.
91. M. (Dallina) Raphaelis.
92. M. (Dallina) septigera.
93. M. tenera.
94. M. venosa.
95. M. Wyvillii.
96. Megathyris decollata.
97. Mühlfeldtia echinata.
98. M. incerta.
99. M. sanguinea.
100. M. truncata.
101. M. " var. monstruosa.
102. M. Willimoesi.
103. Platidia anomioides.
104. P. Davidsoni.
105. P. lunifera.
106. Rhynchonella cornea.
107. R. Döderleini.
108. R. Grayi.
109. R. lucida.
110. Rhynchonella nigricans.
111. R. " var. pyxidata.
112. R. psittacea.
113. Terebratella Blanfordi.
114. T. (Terebratalia) coreanica.
115. T. cruenta.
116. T. (Terebratalia) dorsata.
117. T. Frielii.
118. T. (Terebratalia) frontalis.
119. T. Gouldi (= 78).
120. T. Labradorensis.
121. T. Lamanoni.
122. T. Mariæ.
122*a*. T. (Terebratalia) obsoleta.
123. T. (Terebratalia) occidentalis.
124. T. pulvinata.
125. T. rubicunda.
126. T. rubiginosa.
127. T. Spitzbergensis.
128. T. (Terebratalia) transversa.
129. Terebratula (Liothyrina) Bartletti.
130. T. (L.) Dalli.
131. T. (L.) incerta.
132. T. (L.) Moseleyi.
133. T. (L.) Stearnsi.
134. T. (L.) uva.
135. Terebratulina Cailleti.
136. T. cancellata.
137. T. caput-serpentis.
138. T. (Dyscolia) Crossii.
139. T. Cumingi.
140. T. japonica.
141. T. Murrayi.
142. T. radiata.
143. T. septentrionalis.
144. T. trigona.
145. T. unguiculata.
146. Thecidium Barretti.
147. T. (Lacazella) mediterraneum.

COLOR.

The shells of most living species are of light or neutral tints, white or horn-color. The deep-sea species are usually vitreous, translucent and very thin-shelled. A deep orange-red in radiating bands or in solid tints, colors some species (TEREBRATULINA, KRAUSSINA, etc.); light yellows, deep and light shades of green (LINGULA), black in bands (CRANIA) or masses (RHYNCHONELLA) embellish these shells. Even among the fossil species traces of faded color-marks are occasionally observed; DESLONGCHAMPS has described them among Jurassic species, DAVIDSON among the Carboniferous, and KAYSER has found a color-marked RHYNCHONELLA in the Devonian. The large, highly ornamented species of Palæozoic times, with their external sculpture heightened by a brilliant coloring must have been objects of exquisite beauty.

THE SHELL.

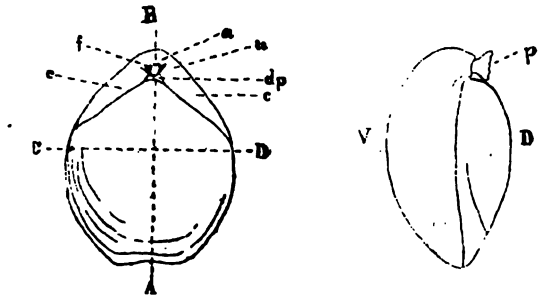
External Form and Terminology of its Parts.

The brachiopod shell assumes a great variety of forms. Usually both valves are more or less convex, but they may be almost flat, and one of them is frequently concave, following the curvature of the other. In early age the surface of all is normally smooth, and while many retain this smoothness throughout their existence, the greater number bear radial ribs or plications, or a series of concentric varices and growth-lines.

The valve, which, in youth or maturity, bears at or near its apex, a perforation or fissure, is known as the *pedicle-valve*, as it is through this opening that the pedicle or fleshy arm of attachment is protruded, being attached to the inner surface of the valve by a series of muscular bands. This valve has also been quite generally known as the *ventral*, as it may, from certain considerations, be regarded as lying on the ventral side of the animal. It is usually the larger of the two valves, and has, therefore, been designated by many writers as the *larger valve;* but there is so great a number of instances in which the pedicle-valve is not the larger, that this term is objectionable. This valve bears the teeth or the principal articulating apophyses of the hinge, and has hence been termed the *dental valve*; an unsatisfactory designation, as a vast number of species is provided with no such apparatus. A few writers have called it the *neural*

valve, because of the location of the principal nerve-ganglia on this side of the body.

The opposite, usually smaller and imperforate valve, is known as the *brachial valve*, as to it are attached the spiral arms or brachia. This is the *dorsal*, *socket* or *hæmal valve* of some writers.



FIGS. 9.— Front and profile views of *Terebratula*.

These valves usually have an articulated *hinge* situated beneath the beaks; sometimes they are held together in simple apposition by muscular contraction, but whenever, and to whatever extent the valves are opened by the animal, the basis of the movement is at this posterior margin of the shell.

In discussing the shells of the brachiopods a simple nomenclature has been adopted.

Most writers are agreed in orienting a shell with its beaks upward. That portion of the valves thus lying above a horizon-

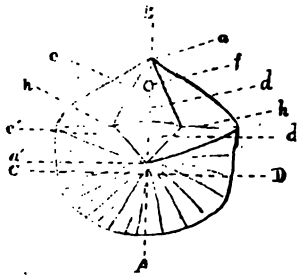


FIG. 10.— *Orthisina*.

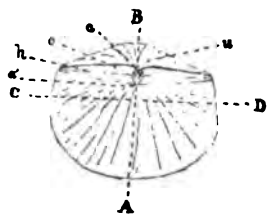


FIG. 11.— *Plectambonites*.

tal axis (C—D) passing through the center of the valves, is the *posterior portion*, that below this axis the *anterior portion*. The shell is also divided by a vertical axis (A—B) into equal *lateral parts*. The *apex* of the valves is their acute or obtuse point of

beginning (a, á), the *umbo* (u), the more prominent portion or *beak* including the apex; the *umbonal slopes* are the inclined surfaces about the umbo, except those extending to the hinge margins, which are known as the *cardinal slopes* (c). The *hinge-line* (h) is the straight or curved line along which articulation takes place; the *cardinal extremities* (e) the exsert terminations of this line; the *cardinal area* (c, ca), a triangular vertical or curved surface, distinctly set off from the general surface of the shell and more highly developed on the pedicle-valve. This cardinal area is transsected by a median triangular aperture having its apex at the apex of the pedicle-valve, its base at the hinge-line; this is called the *delthyrium* (dt) and in function it is a passage for the pedicle.

This aperture is usually closed or covered at some period in the history of the organism; in the earliest growth-stages of the shell, and in primitive genera, it is covered by a single convex

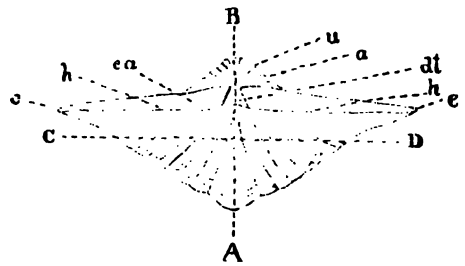
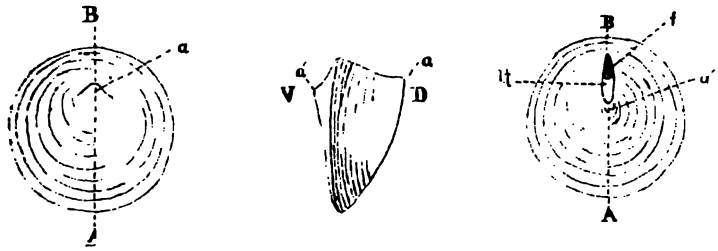


FIG. 12.—*Spirifer.*

plate or sheath, known as the *deltidium* (d). In secondary or derived genera (RHYNCHONELLA, SPIRIFER, ATHYRIS, TEREBRATULA) the deltidium disappears by resorption, at a very early stage of growth, or is never present, and the delthyrium may remain open for a considerable period in the life of the animal; but it eventually becomes more or less completely closed by the gradual formation, along the lateral margins of the delthyrium, of two separate plates (*deltidial plates*, dp), which in the adult condition may either remain discrete or unite along the median line, or having thus united, become coalesced into a single plate (SPIRIFER, CYRTINA), which has the form of a deltidium but is wholly distinct in origin. Both deltidium and deltidial plates may enclose an oval or circular passage or *foramen* (f) for the protrusion of

the pedicle; in the former the foramen is usually apical, but in the latter it generally lies below the apex, and in both cases it may become entirely obliterated by the later growth of the shell. Likewise both deltidium and deltidial plates may be resorbed in the senile stages of growth.

In some of the edentulous genera, as ORBICULOIDEA and SCHIZOTRETA, a structure somewhat analogous to the deltidium is



FIGS. 13.— *Orbiculoidea.*

Pedicle valve. Profile. Brachial valve.

V. pedicle-valve; D. brachial valve; *a*. apex of brachial valve; *a'* apex of pedicle valve; *f*. foramen; lt. listrium.

formed between the apex of the pedicle-valve and the opening for the pedicle, and this area becomes modified by the passage of the pedicle over its surface. It is important to distinguish this from the deltidium of the articulate genera, and it may be termed a *listriate deltidium* or *listrium* (lt).

It is probably true that in the very early growth stages of all brachiopods, the posterior margin of *both valves* was grooved for the passage of the pedicle. This is to some extent the condition in the adult LINGULA, OBOLUS and OBOLELLA. With the reduction in the relative size of the pedicle, and its restriction to the larger valve, the primitive aperture in the brachial valve was closed by a transverse plate similar in appearance to the deltidium, and in function (to close a discarded or abbreviated passage) to the deltidial plates of the opposite valve. This plate was not formed by the secretion and union of distinct lateral plates but by a

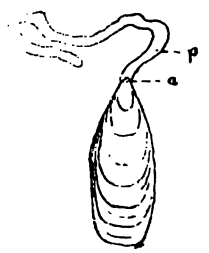


FIG. 14 — *Lingula.*
a Apex of pedicle valve: *p*. pedicle.

general deposition about the margins of the aperture from the apex downward. This plate has been termed the *chilidium* (d') and has been shown to be of secondary growth.

Variations in Form.

The forms assumed by the brachiopods are so diverse that it is often difficult to believe that shells so unlike in contour belong to the same natural group. The habits of these animals and the

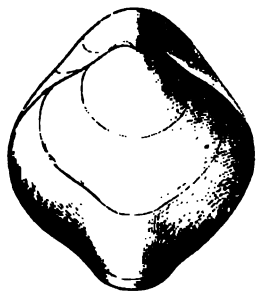


FIG. 15.— *Meristella nasuta.*

FIG. 16.— *Pygope diphya.* *p.* Vascular sinuses. (DAVIDSON.)

FIG. 17.— *Lingula paliformis.*

workings of natural causes in the modification of their shells afford a very substantial aid to the comprehension of these differences.

The youngest shells of all Brachiopoda (so far as they have been studied) are biconvex and sub-semicircular in outline. Those

FIG. 18.— *Orthis subcarinata.*

shells in which the pedicle retains its functions until maturity (LINGULA, TEREBRATULA, MAGELLANIA, RHYNCHONELLA, etc.) and hang freely suspended from the point of attachment, are oval and biconvex throughout their existence. In such shells as LINGULA

and OBOLUS, and the early growth stages of many genera where the pedicle is long and flexible, produced in the vertical axis of the animal, and at the same time not restricted in its passage to one valve, the differences in the form of the two valves are at their minimum, as they are more equably exposed and resistant to external physical impacts. Where there is a decided inequality in the valves, it has been observed in living forms, and is probably equably true of fossil species, that the pedicle is short, rigid and restricted to one valve; and there thus appears to be a certain definite relation between the angle at which the pedicle is protruded and the size of the

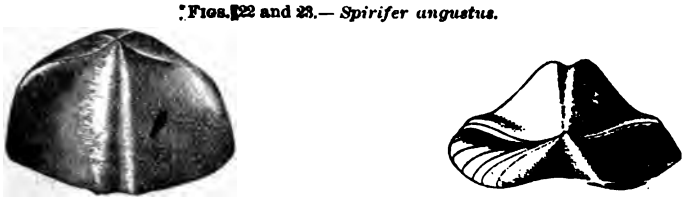
FIG. 19.— *Lingula Murphiana.* (DAVIDSON.)

FIG. 20.— *Athyris subtilita.*

FIG. 21.— *Orthis biloba.*

valves. The pedicle-valve, which, typically, in the adult condition is the larger, is the seat of the principal muscular

FIGS. 22 and 23.— *Spirifer angustus.*



FIGS. 24 and 25.— *Pentagonia unisulcata.*

activity and the main lodgment of the viscera; it is, in a certain sense, the cell of habitation of the animal, and

the brachial valve may be compared to an operculum closing it; and in this fact is probably one efficient reason for the differences of size in the two valves.

FIGS. 26 and 27.— *Rhynchonella acuminata.* (DAVIDSON.)

In DISCINISCA the pedicle is a short plug extending at right angles to the horizontal plane of the valve; and here the lower or pedicle-valve is flat and the upper conical, while in ACROTRETA and CONOTRETA, where the pedicle was probably longer and more flexible, the lower or attached valve is highly conical and the upper nearly flat. As a general rule shells closely attached by a pedicle at this high angle to the plane of the brachial valve have a tendency to circular or subequal peripheral growth (DISCINA, DISCINISCA, ORBICULOIDEA, etc.), and a similar tendency is manifested in shells attached by solid cementation, not only in CRANIA, CRANIELLA, etc., which are hingeless genera, but also such genera as are provided with a hinge, when attached, evince a spreading or ostrean form of growth. Articulate shells, where the pedicle has maintained its function during a considerable portion of the period of adolescence (some species of SPIRIFER, CYRTINA, ATHYRIS, STROPHOMENA, LEPTÆNA, etc.), but later becomes atrophied, so that the animal must have dropped from its support and fallen upon the sea-bottom, are found to combine an elongate form with considerable breadth of hinge, and often with a highly developed cardinal area. In the Oriskany sandstone of Cumberland, Maryland, has been found a fragment of a valve of

FIG. 28.— *Acrotreta gemma.* The pedicle-valve viewed from the posterior slope and from the apex.— (WALCOTT.)

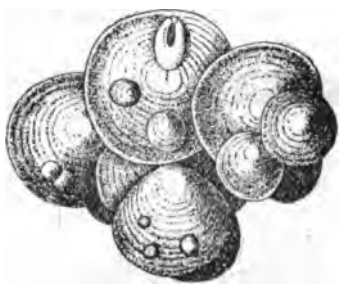


FIG. 29.—A cluster of young and old shells of *Discinisca lamellosa* (SOWERBY).

Spirifer arenosus, to which are attached a number of the young of *Cyrtina rostrata*, in their original position. The specimen shows that attachment by the pedicle in spiriferoid shells brought the cardinal area close and flat against the surface of adherence, the pedicle evidently having been extremely short. In such close attachment, obstructing, from the first, additions to to the posterior margin of the shell, may be suggested an explanation of the origin of the cardinal area and extended hinge.

In concavo-convex species, as of STROPHEODONTA, PRODUCTUS, PLECTAMBONITES, etc., the pedicle was evidently atrophied very early in the history of the individual. Some such shells, as

FIG. 30.—*Spirifer asper*.

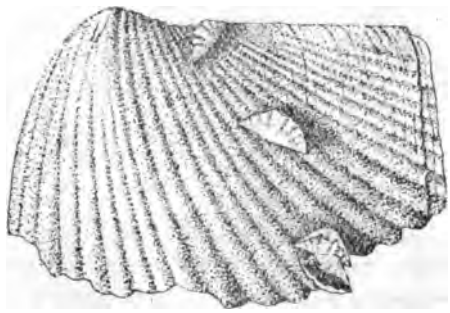


FIG. 31.—Young of *Cyrtina rostrata* attached by the face of the cardinal area to the surface of *Spirifer arenosus*. Oriskany sandstone, Cumberland, Md.

RAFINESQUINA and LEPTÆNA, at times retain at maturity, a slight external evidence of a foramen, or the foraminal passage may even remain open as a minute puncture, but in this condition no sufficient number of muscular fibres could have passed through it to have supported the shell. Such shells, in becoming freed from the surface to which they were attached, would fall upon the sea-bottom, the heavier or pedicle-valve down, so that virtually this still acted as the attached valve. It will readily be understood that the contour of these concavo-convex shells is a necessary result of an obstruction to the marginal growth of the brachial or concave valve, by the more rapid growth of the pedicle-valve.

In many of these shells the pedicle-valve was provided with spines serving to attach it more firmly to its place in the sediment, so that it became less liable to be washed from its position; and among such spiniferous shells we find the greatest convexity of this valve, and often a remarkable extension of its anterior margins (PRODUCTUS). In *Productus* (*Proboscidella*) *proboscideus* and *P. Nystianus*, this modification is carried to an extreme, the pedicle-valve being greatly produced at its free margins which meet on the lower side and form a long tube, while the brachial valve is small, unmodified and operculiform. It has been suggested that the function of this modification is to transmit water to the animal deeply buried in the sediments.

FIG. 32.—*Proboscidella proboscideus* (ETHERIDGE).

An opposite extreme of form occurs in certain nearly plane species of STROPHEODONTA (LEPTOSTROPHIA; plate 15, figs. 1-4), in which the two valves have maintained an equable growth for their entire extent.

There are a few shells of this concavo-convex group, whose valves have a double curvature. Thus in STROPHOMENA, STROPHONELLA and CHONOSTROPHIA, the contour of the two valves in youth, or in the umbonal region of adult shells, is normal, the pedicle-valve being convex, the brachial concave; but in later growth this contour becomes reversed, and the general concavity of the shell is on the pedicle-valve and its convexity on the brachial valve. The causes of such reversion in contour can only be due to an accelerated growth of the brachial valve after the early stages have been passed; and it may be observed that species of STROPHONELLA are all, virtually, reversed Stropheodontas. STROPHEODONTA is a genus which in its adult state, at successive periods in its history, exhibits in a most remarkable manner various phyletic developmental phases. Thus its earlier (Silurian) representatives

FIG. 33.—*Strophomena deltoidea.*

FIG. 34.—*Strophomena Wisconsinensis.* Profile view showing the convexity of the brachial valve and the concavity of the pedicle-valve in the umbonal region.

(BRACHYPRION) have the delthyrium either open or partially closed by a convex deltidium, and the crenulations of the hinge-line restricted to the immediate vicinity of the delthyrium. Gradual progress in these features is observable throughout the late Silurian

FIG. 35. - The cardinal area of *Strophcodonta (Brachyprion) Leda*; showing the few crenulations on the cardinal margin near the delthyrium. Clinton group. (BILLINGS.)

FIG. 36. - The cardinal area of *Strophcodonta (Brachyprion) profunda*, with more numerous cardinal crenulations. Niagara group.

and early Devonian species; and in the middle or later Devonian when the genus disappears, the species have the delthyrium completely closed, the outlines of the deltidium obliterated and

FIG. 37.—The hinge area of *Strophonella ampla*; showing the extension of the cardinal denticulations for about one-half the length of the hinge-margin.

FIG. 38.—The cardinal area of *Strophcodonta demissa*, with the crenulations extending to the extremities of the hinge.

the crenulation of the hinge extending to the cardinal extremities. There is corresponding progress in the development of the internal features. With each phase of STROPHEODONTA there is, in

FIG. 39.—The cardinal areas of *Strophcodonta demissa*; showing the closed delthyrium.

the same fauna, a corresponding phase of the reversed shell STROPHONELLA. In a certain sense the genera RAFINESQUINA and STROPHOMENA bear a similar relation to each other, both appearing and disappearing in geological history at about the same time.

Ornamentation of the External Surface.

The surface of the brachiopod shell is rarely entirely smooth. It may bear only the concentric lines or varices of growth, and sometimes squamous, lamellar expansions, but as a general rule, the surface is covered with radiating striae, lines, plications or ribs, which may either be of equal size, may alternate in size, or

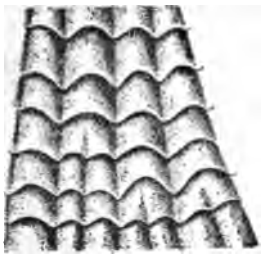


FIG. 40.—The lamellose surface of *Atrypa aspera*.

FIG. 41.—The concentric lamellæ of *Atrypa imbricata*; enlarged. (DAVIDSON.)

be arranged in fascicles. Such configuration is of secondary growth, the incipient shell being free from it, except in rare instances where evincing an acceleration of development in this

FIG. 42.—A portion of the exterior of *Atrypa reticularis*; showing the extension of the lamellæ and their tendency to fold upward into hollow spines.

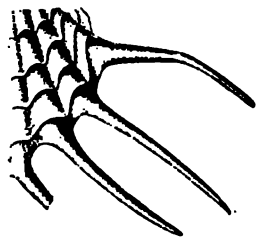


FIG. 43.—The surface spines of *Atrypa hystrix*.

respect, or in other words, an earlier inheritance of specific characters. In the plicated shells, the plications of one valve generally alternate in position with those of the other, so that on the margins, the edges of the two series are interlocked, effecting complete closure.

The concentric lines when not wholly superficial may be regarded as representing periodic interruptions in the outward expansion of the mantle. In some genera, as ORBICULOIDEA, DISCINISCA, TRIMERELLA, etc., there are frequent irregular lamellose expansions of the outer shell layer, which produce a rough, squamous exterior (Plates 5, 6.). In species of ATHYRIS, ATRYPA, and, rarely, PRODUCTUS, there are regular expansions at the concentric lines, which are sometimes extravagantly extended (*Athyris concentrica*, *A. planosulcata*, *A. lamellosa*, *Atrypa reticularis*, etc.): in other species the concentric lamellæ become divided into a fringe of flat, hollow spines. Again, in SIPHONOTRETA, ATHYRIS, and SPIRIFER, there are rows of hollow, round spines, which are sometimes divided by a median partition (*A. hirsuta*) and may be compound, with pinnate lateral branches. (*S. fimbriatus*.) (See Plate 25, fig. 12). When the spines are irregularly scattered over the surface they are are generally of larger size. This is preeminently the case in PRODUCTUS, where the spines are often of great size and remarkable length. Such spines could never have been flexible, but they were frequently a means of attachment to foreign bodies, whether by cementation as in STROPHALOSIA, or by anchoring in the sediment.* In the younger conditions of such spiniferous shells the spines have, to some extent, opened into the inner cavity of the shell, but in later growth they became, for the

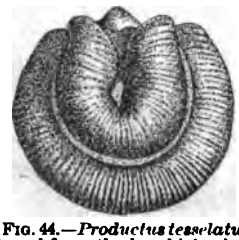


FIG. 44.—*Productus tesselatus*, viewed from the brachial valve; showing the curved fringes. (DAVIDSON.)

FIG. 45.—*Athyris planosulcata*, with its marginal expansions. (DAVIDSON,)

* It has been stated by YOUNG that in some species of PRODUCTUS the large spines appear to be furnished on the interior with a multitude of spinules standing convergent to the axis of the spine. This observation has not yet been verified by others.

most part, closed. This statement, however, is not true of CHONETES where there is a single row of short marginal spines on the cardinal margin of the pedicle-valve alone; these cross the

FIG. 46.—Portion of the shell of *Siphonotreta*; enlarged. (KUTORGA.)

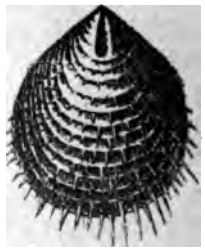


FIG. 47. — *Schizambon fissus*. (KUTORGA.)

cardinal substance of the valve, have wide, internal openings and are believed to be closed at their outer extremities. In ANOPLIA these tubular passages exist, but are not extended into spines (see Plate 20, figs. 15-19). Some species of SIPHONOTRETA and STROPHALOSIA have the spines corrugated. In a few genera the cuticular or outer layer of the shell bears a reticulated or tesselated ornament, or series of coarse punctures arranged in quincunx (TREMATIS, EICHWALDIA, PORAMBONITES), or in radial rows (ORTHIS, PORAMBONITES; Plate 6). The surface is often granulose, especially in species which possess a punctated shell, and sometimes in other shells, as SPIRIFER. The genus LEPTÆNA is characterized by coarse concentric wrinkles or undulations over the horizontal or visceral area of the valves; rarely there are two series of fine oblique concentric wrinkles, as in CHONOPECTUS. It has been observed that the greatest modifications of the exterior occur on the pedicle valve, and this difference may be largely explained by comparing the brachiopod with the bryozoan. If the brachial or upper valve of the former corresponds to the operculum of the latter, it is then the pedicle-valve which, as above suggested, may be regarded as the cell or main receptacle

FIG. 48.—*Chonetes scitula*. Showing the tubes connecting the hollow marginal spines with the interior of the shell; enlarged.

of the animal, and is therefore more highly specialized and more susceptible to variation in its external form.

Cardinal area.— In many of the dentiferous or articulate brachiopods a conspicuous feature of the shell is the specialization of the posterior portion of the pedicle valve as a vertical or curved triangular area. The same character is sometimes present

FIG 49. — Cardinal area of *Scenidium insigne*; enlarged.

FIGS. 50 and 51.— *Orthothetes arctostriata*; showing cardinal area and deltidium.

on the brachial valve, though less highly developed. In genera, which have a straight or extended hinge-line, this area attains its most conspicuous development. It does not bear the ornamentation of the rest of the external surface, but is smooth, or with horizontal lines of growth crossed by vertical lines of structure.

It has already been suggested that this area probably originated from the close attachment of the animal by its pedicle,

FIG. 52.— *Spirifer granulosus*; showing the cardinal area.

which obstructed the outward growth of the valves. The intimate structure of this portion of the shell does not, however, differ materially from that of the remainder. In forms which were evidently suspended freely throughout their later existence, by a moderately long arm, this area does not exist (TEREBRATULA, RHYNCHONELLA, etc.), and this may be due to the fact that the posterior growth of the valves was unobstructed by close adhe-

sion to the object of support. Among the edentulous genera there is rarely the least indication of such an area. In ACROTRETA, CONOTRETA, ACROTHELE, IPHIDEA, etc., where the foramen is apical there is a posterior flattening of the pedicle-valve, upon which the concentric ornamentation of the shell is retained. This has sometimes been inaccurately termed a "false cardinal area," or a "pseudo-area." Though not so sharply defined as the cardinal area in the articulate brachiopods, it is nevertheless an homologous structure and needs no other designation. In such genera as DISCINISCA, ORBICULOIDEA, etc., there was no obstruction to the posterior growth of the shell, and therefore no cardinal area.

The Delthyrium and its Coverings.

By the term *delthyrium* is meant the median triangular fissure or cleft which crosses the cardinal area of the pedicle valve; or when that area does not exist, traverses

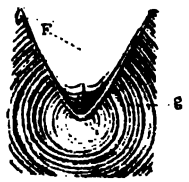


FIG. 53.—Pedicle passage of *Schizocrania filosa*. *F*, triangular pedicle fissure; *g*, listrum.

FIG. 54.—*Trematis terminalis*. Interior of pedicle-valve. *F*, foramen; *v*, vascular sinuses; *p*, pedicle-groove.

the posterior surface from apex to cardinal line. It is the passage for the pedicle, and always subserves this function when existing in an uncovered condition in adolescent or mature growth. In ORTHIS this is its normal condition at maturity; but it has been shown that the open delthyrium at this stage, in *Orthis varica*, is actually a modified phase, the shell having assumed in youthful growth a convex covering or deltidium, which is subsequently resorbed. In SCHIZOCRANIA the triangular slit is retained in all stages of growth, and in TREMATIS its outer edges converge at maturity, while in ORBICULOIDEA it is altogether a feature of early growth, the adult shell having the passage closed by the union of the edges on the posterior margin, and the contemporaneous formation of a transverse plate or *listrum* beneath the apex. In the inarticulate genera IPHIDEA and VOL-

BORTHIA the place of the delthyrium is covered by a convex ridge; in ACROTRETA and CONOTRETA there is a groove instead of a ridge.

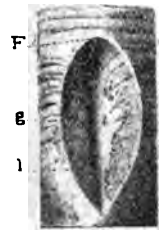


FIG. 55.—Pedicle-groove of *Orbiculoidea tenuilamellata*. *F*, foramen; *g*, base of groove; *l*, walls of groove.

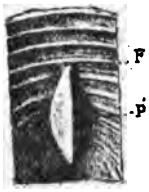


FIG. 56.—Pedicle-area of *Orbiculoidea Herzeri* viewed from within. *F*, foramen; *p*, under surface of listrium.

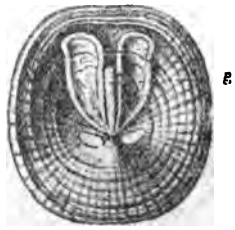


FIG. 57.—Interior of pedicle-valve of *Orbiculoidea nitida*. *F*, foramen; *g*, inner surface of pedicle-groove or listrium. (DAVIDSON.)

The convex ridge or plate which has been termed the *deltidium* in the articulate brachiopods is retained in many genera at maturity (PROTORTHIS, BILLINGSELLA, STROPHEODONTA, STROPHOMENA, LEPTÆNA, ORTHOTHETES, DERBYA, etc., etc., Plates 8, 13, 19) and it usually exists in all species which have the cardinal area developed. That it is not always retained may be due to different causes. Its union with the margins of the delthyrium are lines of weakness along which it is often readily separated from the valves; it may be gradually abraded or become resorbed by the animal.

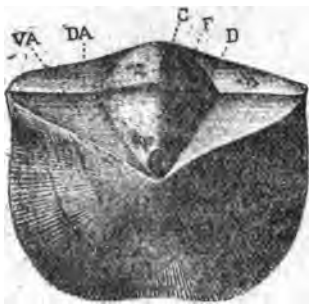


FIG. 58.—*Clitambonites* (*Orthisina*) *anomala*. VA, cardinal area of pedicle-valve; DA, cardinal area of brachial valve; D, deltidium; C, chilidium; f, foramen. (DEVERNEUIL.)

In some of the dentiferous genera in which the cardinal area is very obscurely defined and the umbo of the pedicle-valve closely incurved (PENTAMERUS, AMPHIGENIA), the deltidium is concave, and the pedicle probably not functional at maturity.

In most of the articulate genera, however, such as TEREBRATULA, RHYNCHONELLA and their allies, MERISTA, MERISTELLA, RETZIA, etc., etc. the covering of the delthyrium consists of two convex plates formed by gradual growth along the margins of the opening and uniting in the median line; bounding the lower side of, or encircling the pedicle. Various stages in the development of these

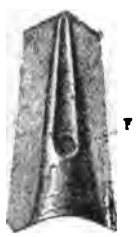


FIG. 59.—Deltidium of *Cyrtina*. F, foramen. (DAVIDSON.)

deltidial plates are attained at the maturity of different species. (Plate 23, figs. 11 and 12.) Thus, in ***Meristina***

FIGS. 60, 61, 62.—*Whitfieldella nitida*; showing the progressive closing of the deltidium by the growth of the deltidial plates. The figures at the right represent immature conditions, that at the left the adult state.

FIG. 63.—The adult condition of the delthyrium in *Meristina rectirostra*, showing the absence of deltidial plates.

rectirostris they are but feebly, if at all developed, evincing either the embryonic or degenerate character of the adult in this respect; while in ***Eumetria*** *Verneuiliana* they are closely united by coalescence from the apical foramen to the hinge and their convexity wholly obliterated.

FIG. 64.—*Rhynchonella Grasiana*, showing the extravagant growth of the deltidial plates in the adult (DESLONGCHAMPS.)

With present evidence, these deltidial plates appear to be a secondary modification of the delthyrium, induced after the disappearance of the original covering of this passage from the causes already suggested.

In many of the articulate genera the delthyrium, if left open either from resorption of its normal coverings or from a failure to develop them, becomes filled by a progressive secretion of testaceous matter in the later stages of growth. This is especially marked among a certain group of the Spirifers where this callous growth forms a more or less complete transverse plate; and the extreme result of this development is exhibited by the genus SYRINGOTHYRIS, in which this condition of hypertrophy in the shell glands, produces not only a complete transverse plate covering or partial filling of the cavity extending from

FIG. 65.—A cardinal view of *Spirifer asper*; showing the callosity in the delthyrium.

the apex nearly to the basal margin of the delthyrium, but also builds up on the inner side of this plate a tubular sheath, open along its ventral surface and which probably inclosed the atrophied pedicle of the animal. This peculiar tubular structure may be termed the *syrinx*.

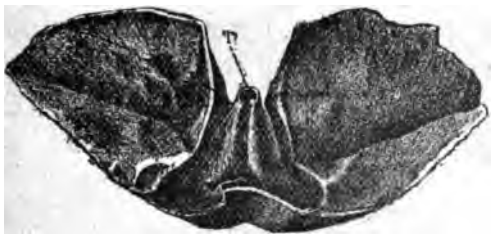


FIG. 66.— Interior of pedicle-valve of *Syringothyris*. T, the split tube or syrinx.

FIG. 67.—*Syringothyris typa*. The interior of the umbonal portion of the pedicle-valve, showing the split-tube or syrinx attached to the transverse plate filling the delthyrium.

The covering of the delthyrium in the brachial valve (*chilidium*) which is always a single plate is of later growth than the deltidium, and is therefore not a primitive structure.

FIG. 68.— Cardinal view of a portion of the valves of *Orthotheles subplana*; showing a remarkable development of the chilidium.

THE INTERNAL CONFIGURATION OF THE VALVES.

Articulating Apophyses.

Articulation of the valves is mainly effected by means of *teeth and sockets*, the former on the pedicle-valve, the latter on the brachial valve. In inarticulate genera the valves are usually held in apposition simply by muscular contraction, and seldom is any tendency to the formation of articulating processes manifested. Occasionally low bosses are formed on the cardinal margin of the pedicle-valve (TRIMERELLA, BARROISELLA, TOMASINA; Plate 1, fig. 14), which probably subserved to a certain extent the pur-

poses of a hinge. In the articulates the teeth lie at, or just beneath the cardinal margin, and at either side of the delthyrium. They are short processes, free at their extremities, which are frequently curved upward or backward into their sockets in the opposite valve, thus locking the valves in such a manner that it often becomes impossible to separate them without breaking the teeth. Both teeth and sockets vary considerably in their development in different genera, and in different species of the same genus, but they are invariably two in number and are always constructed on the same plan.

Articulation is also aided by the *cardinal process*, an apophysis situated at the center of the hinge of the brachial valve, and which in certain extinct genera, as STROPHEODONTA, DERBYA, NUCLEOSPIRA, PRODUCTUS, STRINGOCEPHALUS, is of a very considerable size. This process was a surface of attachment of certain muscles, which, by their contraction, opened the valves, and its size is due to the fact that testaceous matter has been rapidly secreted about the extremities of the muscular bands. It is in the later stages of growth that the cardinal process obtains notable size, and that usually in species where the pedicle has become atrophied and is no longer an obstacle to its growth. The posterior surface of this process, which was the surface of muscular attachment, is variously lobed, furrowed or striated. (Plates 9-22.)

FIG. 69.—*Rafinesquina alternata*. Interior of the brachial valve.

The cardinal process is frequently connected with, and often merged into, an elevated central *hinge-plate*. This plate is not found in genera where the cardinal process attains its highest development (STROPHOMENA, DERBYA, ORTHOTHETES, TRIPLECIA; Plates 16, 17 and 18), but, rather in those whose brachia are provided with calcified supports (MERISTELLA, RETZIA, ATHYRIS, TEREBRATULA, etc.), and while it is in some degree a surface of muscular attachment, it also serves as a support to the bases of the brachia (*crura*).

The inner margin of the hinge in both valves frequently bears a series of fine, interlocking denticulations, making an arrangement which contributes to the firmer union of the valves (STROPHEODONTA, SPIRIFER, etc.). Interlocking plications about the lateral and anterior margins of the valves serve a similar end.

FIG. 70.—*Conchidium Knighti.* Longitudinal section, showing the septa (*s*) and spondylia (*a*, *b*) of both valves, and the crura (*c*). (DAVIDSON.)

Septa.

Vertical plates or *septa* divide the interior cavity of the valves of some genera in various ways. The teeth are frequently supported by such plates, one on each side of the delthyrium of the pedicle valve, and these are known as *dental plates*. Such plates may rest upon the inner surface of the valves or converge and unite, forming a spoon-shaped process, or *spondylium*, which is sometimes free, except at its posterior margin, but is usually supported by a *median septum* (CLITAMBONITES, PENTAMERUS, CAMAROPHORIA, etc.). When the spondylium is not present in the

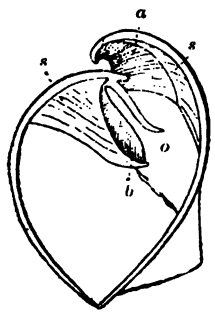


FIG. 71.—*Camarophoria Schlotheimi.* *s*, median septa; *c* crura; *a*, spondylium of pedicle-valve; *b*, spondylium of brachial valve. (WOODWARD.)

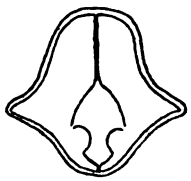


FIG. 72.—*Siberella Sieberi.* Transverse section showing the spondylia supported by median septa.

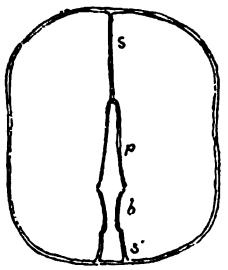


FIG. 73.—Transverse section of *Conchidium Knighti*. *s*, median septum of pedicle-valve; *s'*, septa of brachial valve; *p*, spondylium of pedicle-valve; *b*, crura, plates.

pedicle-valve, a median septum often divides the muscular region and itself becomes a surface of muscular attachment (ENTELETES, SPIRIFERINA). There may also be one or more *lateral septa* on each side of the median one, as in the genus POLYTECHIA (Plate 8, figs. 16–20); this, however is of rare occurrence.

In the brachial valve the *crura* or bases of the brachial processes may be supported by divergent vertical septa, known

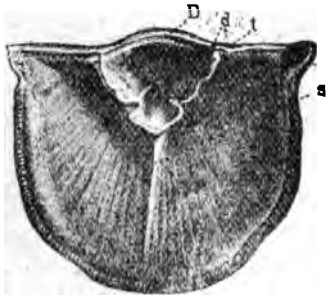


FIG. 74.—Interior of pedicle-valve, of *Orthisina anomala*. D, deltidium; *t*, teeth; *d*, dental plates, forming a spondylium; *s*, median septum. (DAVIDSON.)

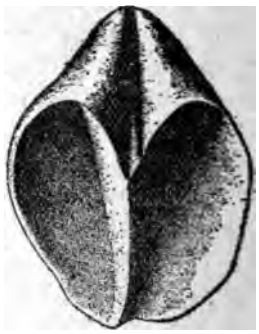


FIG. 75.—The interior of the pedicle-valve of *Conchidium*; showing the spondylium.

as the *crural plates*. These may also converge and form a spondylium. Accompanying these, or independent of them, may be a prominent median septum (ENTELETES, KAYSERELLA, PENTAMERUS); and the latter may support the spondylium. There may also be two parallel median septa supporting the convergent, but not united crural plates (BARRANDELLA, PENTAMERUS, CONCHIDIUM). In the inarticulate genera the median and lateral septa are sometimes well developed, but do not often attain great size (LINGULA, DIGNOMIA, GLOTTIDIA, LINGULASMA, etc.).

FIG. 76.—*Lingula Delia*, with median septum (*s*).

Muscular scars.

The impressions made upon the shell by the attachment of the muscles are usually confined to the umbonal and posterior portions of the valves. There are some exceptions to this rule, as in the case of *Hipparionyx proximus* and a few members of the orthoid genus RHIPIDOMELLA, where the great scars of the pedicle-valve extend almost to the anterior margin of the shell. The impressions of the several muscular bands are retained with various degrees of distinctness; among the fossils they are often merged with one another, so that only the outline of the muscular area, as a whole, is visible. Among the articulate genera one plan of arrangement is maintained without essen-

tial modification. In the middle line of the pedicle-valve is a narrow oval impression of the *adductor muscle*, which is divided medially into two scars; at the sides are two pairs of scars, the larger in front (*diductors*), the smaller behind (*pedicle-muscles*).

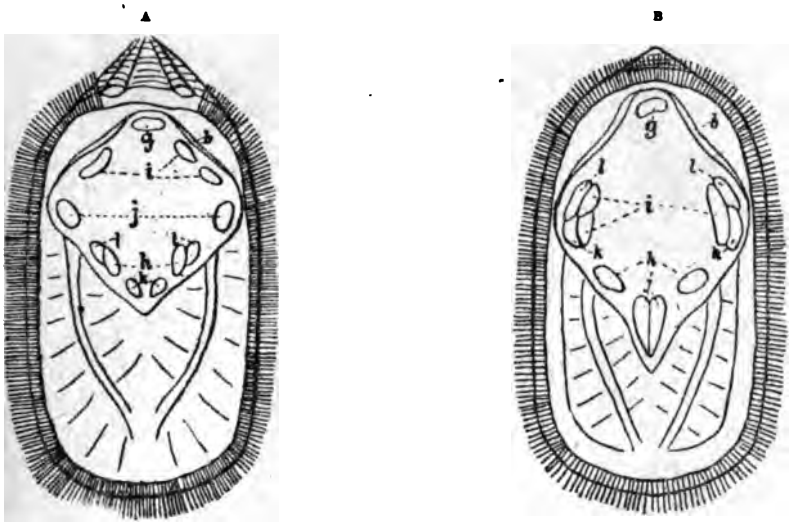
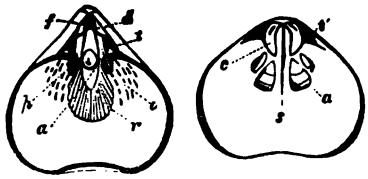


FIG. 77.—Muscular system of *Lingula anatina*: A, pedicle-valve; B, brachial valve; *b*, parietal scar; *g*, umbonal muscle; *i*, transmedians: *h*. centrals; *j*, *k*, *l*, laterals (*j*, anteriors; *k*, middles; *l*, externals). (DAVIDSON.)

Occasionally the scars of a small *accessory* pair of *diductors* are found just behind the adductor scars; and behind these is an

FIG. 78.—*Craniella Hamiltonicæ*. The attached valve, showing the anterior and posteror adductor scars.



FIGS. 79, 80.—Interiors of the pedicle and brachial valves of *Rhynchonella (Hemithyris) psittacea*; *f*, foramen; *d*, deltidial plates; *t*, teeth; *t'*, dental sockets; *p*, pedicle muscle; *a*, adductors; *r*, diductors; *o*, ovarian markings; *c*, crura; *s*, septum.

FIG. 81.—Interior of the pedicle valve of *Orthis Clytie*, showing the pedicle, adductor and diductor scars.

undivided scar of the *pedicle-muscle*. In the brachial valve there are four undivided adductor scars in two distinct pairs, one the *anterior*, the other the *posterior* pair. This arrangement of the

scars is very simple compared with that found in some of the inarticulate genera (LINGULA, DISCINISCA), but among the fossil

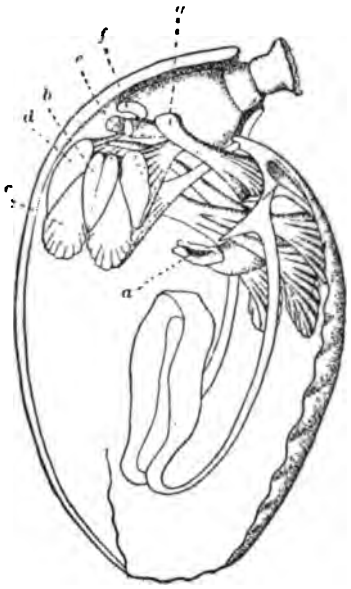


FIG. 82.—Muscular system of *Magellania australis*. *a*, mouth; *b*, adductors; *c*, diductors; *d*, ventral pedicle muscles; *e*, accessory diductors; *f*, median pedicle muscle; *g*, dorsal pedicle muscle. (WOODWARD.)

species of such genera the muscular impressions are rarely retained with distinctness. For the fuller elucidation of this

FIG. 83. Interior of the pedicle-valve of *Atrypa spiriferoides*; showing adductor and diductor scars

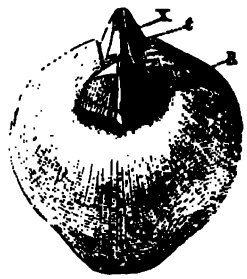


FIG. 84.—Internal cast of the pedicle-valve of *Meristella nasuta*; *N*, filling of rostral cavity; *t*, position of teeth

subject the student is referred to the chapter on the MUSCULAR SYSTEM.

Pallial Sinuses and Genital Markings.

Traces of these features are frequently retained on the shell with more or less distinctness. The *pallial sinuses* are usually

FIG. 85.— Interior of brachial valve of *Lamellibocoelia umbonata*; showing the four adductor scars.

FIG. 86.— *Eatonia peculiaris*. The pallial sinuses on an internal cast of the pedicle-valve.

two convergent (LINGULA, OBOLUS) or divergent (STROPHOMENA, STROPHEODONTA, etc.) trunks, from the outer margins of which

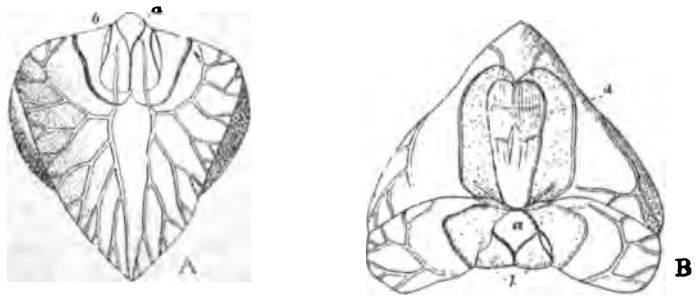


FIG 87.— *Rhynchonella acuminata*, showing the pallial sinuses on an internal cast. A pedicle valve; B, umbonal view; *a*, adductor scars; *b*, diductors. (WOODWARD.)

emanates a series of secondary ramifying branches. Among the inarticulates there may also be branches along the inner margin

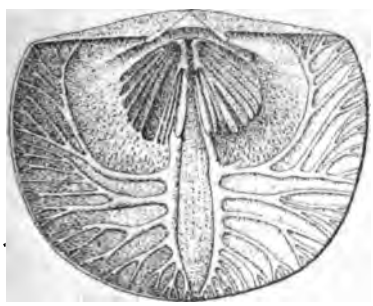


FIG. 88.— *Rafinesquina expansa*. Interior of pedicle-valve, showing pallial sinuses. (DAVIDSON.)

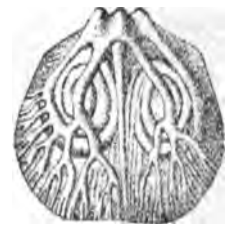


FIG. 89.— *Koninckina Leonhardi*; interior of brachial valve, showing pallial sinuses crossing the impressions of the spiral arms. (WOODWARD.)

of these sinuses. In STROPHOMENA, STROPHEODONTA, etc., the inner margin of the main trunks bounds the genital area, which

usually has a pitted surface. In SCHIZOPHORIA there are four or more subparallel longitudinal main pallial sinuses which subdivide toward their distal extremities. (Plate 11, figs. 21–23.)

Further reference will be made to the structure of the sinuses and genital organs.

Structure of the Test.

The valves of the Brachiopoda are composed of successive laminæ of heterogeneous structure. These may be wholly calcareous, and not more than two or three in number, or alternately calcareous and corneous, and not restricted to any numerical limit. Shells largely corneous or chitinous in their composition are restricted to the inarticulate division, but the inarticulates do not all possess corneous shells. In the living LINGULA there is an alternation of corneous and calcareous layers varying in thickness, the former being compact and imperforate, the latter fibrous or prismatic and crossed by a great number of minute tubules. In fossils of this group the calcareous matter is frequently more or less removed, so that shells in this condition may appear to be essentially corneous in their composition. In the group of fossil linguloids, beginning with LINGULA, passing through LINGULOPS and LINGULASMA to TRIMERELLA and its allies, there is a regular increase in the relative amount of calcareous matter in the shell, so that the Trimerellas, which are large and ponderous shells, seem to have wholly lost their corneous matter. In CRANIA also, the shell is essentially calcareous and the successive layers are punctured by tubules or vertical canals, which are largest at their openings on the interior of the valves, and narrow toward the outer surface. These never pierce the thin outer or epidermal layer of the shell.

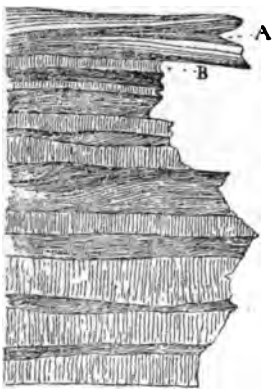


FIG. 90.—Magnified section of the thickest portion of the shell of *Lingula anatina*. *a*, corneous layers; *b*, mineral layers with vertical canals. (GRATIOLET.)

he articulate genera, under favorable preservation, e distinguished three distinct calcareous shell layers; smatic or fibrous layer, which the greater portion of the e this is a thin lamellar layer, ter surface of the shell is cov- enuous epidermal film or *peri-*

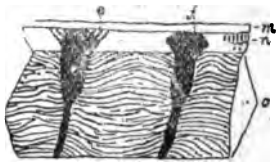


FIG. 91.—Shell structure of a punctate articulate branchiopod. *o*, prismatic layer; *m*, outer, im punctate layer; *n*, intermediate, laminar layer; *f*, broad extremity of perforation; *e*, radiating grooves about extremity.—(KING.)

When the shell is punctate, ently the case (the orthoids, PIRIFERINA, the productoids, ids) the tubules open on the e in narrow apertures, whence upwards, abruptly expanding in the lamellar layer, pper margin they terminate. They do not pierce the

nner surface of a *oductus semireticu-* g the opening of a d the elevated ter- f the puncta (*b*).

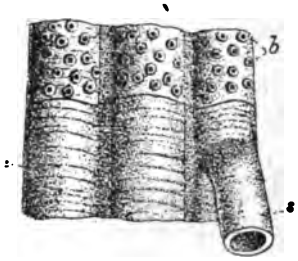


FIG. 93.—Portion of outer surface of *Productus longispinus*. *s*, spine; *c*, imperforate outer layer; *b*, punctæ of inner layer. (DAVIDSON.)

m, and it has not been demonstrated that any brachio- is completely traversed by them. Certain species of DIPHOMELLA) have been shown by YOUNG to possess punctures which were probably the points of insertion inules; these coexist with fine tubules which perfo- ner layers. The coarser spines occurring in such SIPHONOTRETA and PRODUCTUS are hollow, and may penetrate the entire substance of the shell. The per- ary greatly in size and number. In the terebratuloids

they are frequently visible to the unaided eye; in SYRINGOTHYRIS they are often difficult of discernment, and among fossils generally have probably been to some degree obscured by the process of fossilization. In smooth shells they are usually equally disseminated, but in plicated species they are arranged in rows on the plications or in the furrows. They may traverse the shell vertically, but their tendency is usually obliquely forward in the direction of shell-growth, and in some instances (*Tropidoleptus carinatus*) they converge toward the plications. Such variations in arrangement may leave certain portions of the shell impunctate while other portions are richly supplied with tubules.

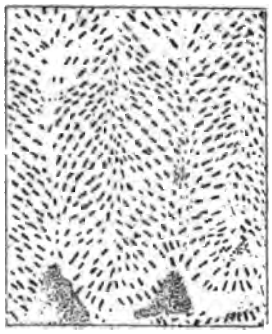


FIG. 94. – An enlargement of the shell structure in *Tropidoleptus*; showing the convergent tubules.

The full taxonomic significance of these test-perforations and their function, is not as yet understood. In certain groups of shells some of the members may be punctate, others impunctate. Thus among the orthids we find that the earlier and typical members (*O. callactis*, etc.), are completely impunctate; so also are PLATYSTROPHIA, HEBERTELLA and DINORTHIS; while the greater number of species belonging to the group, especially its later (Upper Silurian, Devonian and Carboniferous) members, are richly punctate. The shell of SPIRIFER, again, is normally impunctate, while the closely related genera CYRTINA, SPIRIFERINA and SYRINGOTHYRIS are punctate, and even a few species which must still be referred to the genus SPIRIFER have a sparsely punctated shell (*S. plenus*). RHYNCHONELLA and its recent and fossil allies are impunctate, except RHYNCHORA and RHYNCHOPORA, which are simply rhynchonellids with punctate shell.

FIG. 95. An enlargement of an exfoliated surface of *Spirifer plenus*; showing the shell punctations.

There are certain conditions which appear to have induced the deposition of impunctate shell-matter even in species uniformly

. JOUBIN has shown that the deposits about the edges of the muscular without perfora- e same is true of tious deposits in shells; senile en- s of the teeth and ocess, the callosi- e delthyrium, as t, and the syrinx THYRIS. Whether and other articu- physes are im- n their earlier condition, has not been determined. eous secretions in the brachia (spirals, loops, etc.,) are ctate.

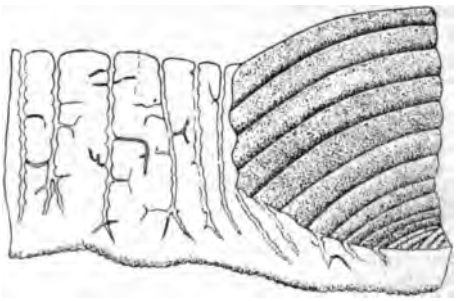


FIG. 96.—Vertical section of an attached valve of CRANIA, showing the normally perforate shell, and the imperforate deposit beneath the muscular scar (JOUBIN).

e function of the punctæ, it is quite generally believed are connected with the respiration of the animal. In ctate species the tubules are filled ula from the mantle, which are en by dissolving the shell of a id in dilute acid. The fact, how- they are not exposed to the water tremities may interfere with this ion, unless an increased exposure l by the access of water from e body chamber. It has been by MORSE that the punctæ in LINA appear only after the shell its earliest growth-stages.

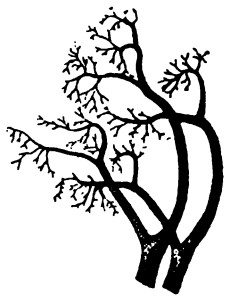


FIG. 97.—Extremities of the shell perforations in CRANIA.—(JOUBIN).

THE ANIMAL.

General Characters.

ening the valves of a living brachiopod, the body, or of it which contains the essential organs, is found ricted to the posterior part of the internal cavity, nterior one-half or two-thirds of this space is filled iled arms from which the name of the class is The degree to which the valves can be voluntarily the animal is very restricted, only sufficient to freely

admit water currents to the brachia (TEREBRATULINIA, MAGELLANIA, etc.), or to extend the brachia when they are protrusible, as in HEMITHYRIS, etc. In *Lacazella mediterranea* the brachial valve in opening may traverse an arc of 90°, but no other species is known to possess this capacity. The *viscera* are separated from the cavity of the brachia by a vertical membranous wall, which is an extension of the *pallium* or *mantle*. The *shell-cavity* is, therefore, divisible into a posterior or *visceral cavity*, and an anterior or *brachial cavity*.

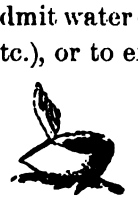


FIG. 98.—*Lacazella mediterranea*, with the valves open as in life. (LACAZE-DUTHIERS.)

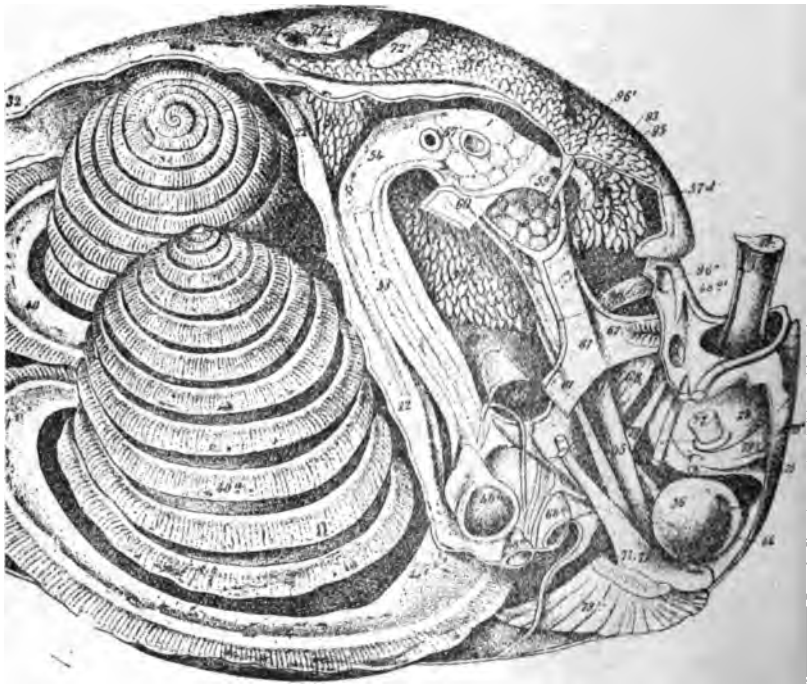


FIG. 99.—*Rhynchonella (Hemithyris) psittacea.*

The valves and a portion of the mantle removed, showing the vertical wall (32) dividing the body cavity into a posterior or visceral, and an anterior or brachial chamber. The notation of the other parts is as follows:

25, pedicle.
28, capsule of pedicle.
32, upper mantle lobe.
33, lower mantle lobe.
40, 40a, brachia.
46, 46a, brachial canal.
48, 48a, crural canal.
48a' aperture of same.
53, œsophagus.
54, stomach.
55, intestine.
56, blind extremity of intestine.
57, b, c, d, liver.
57', hepatic canals.
59, 60, gastroparietal band.
61, iloparietal band.
63', 62' mesentery.
64, genital organs.
67, ventral funnel of oviduct.
68, tube of same.
71, 72, 71', 72' anterior and posterior adductors.
73, 73a, diductors.
75, 77, accessory diductors
79, pedicle-muscle.
93, heart.
95, aorta
96, pallial artery.
96' 96' dorsal and ventral branches of same.
(BRONN after HANCOCK).

THE MANTLE.

This is a thin transparent membrane, appearing in the embryonic condition of the animal, as two distinct lobes. It is, primarily, the shell-secreting gland of the animal, and in all periods of growth it lines the entire inner surface of the shell.

In CRANIA, it is composed of three layers, a middle one, of compact, non-celluliferous tissue or cartilage, on each surface of

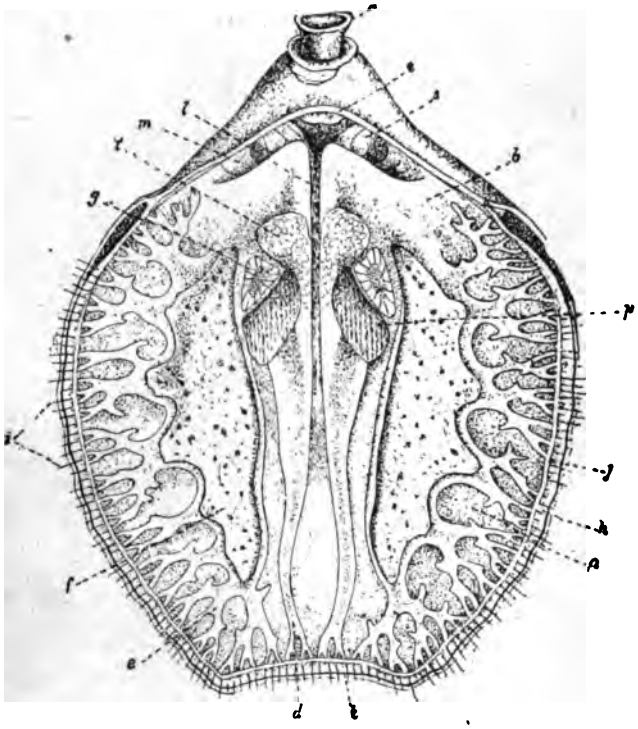


FIG. 100.—The animal of *Magellania australis*, viewed from the dorsal side.
a, mantle; *b*, body; *c*, pedicle; *d*, trunks of pallial sinuses; *e*, branches of pallial sinuses; *j*, genital organs; *g*, posterior adductor muscles; *h*, marginal fold of mantle; *i*, setæ; *j*, circumpallial vessel; *k*, edge of mantle; *l*, median fissure corresponding to septum of valve; *m*, depression caused by hinge-plate: *p*, anterior adductor muscles; *r*, diductors; *s*, accessory diductors; *t*, liver.—(HANCOCK.)

which is a single layer of cells. From that which lies against the surface of the shell arise the cæca or blind tubes which enter the perforations of the test. At various points the mantle, or certain of its layers, folds upon itself, inclosing cavities or pallial sinuses which contain the circulating fluids and often portions of the genital organs. These sinuses frequently modify the interior

of the valves so strongly that their traces are visible when the shell is petrified, and may be seen not only over the brachial region but also where the mantle is extended posteriorly between the margins of the visceral area and the edges of the valves (the *parietal region*).

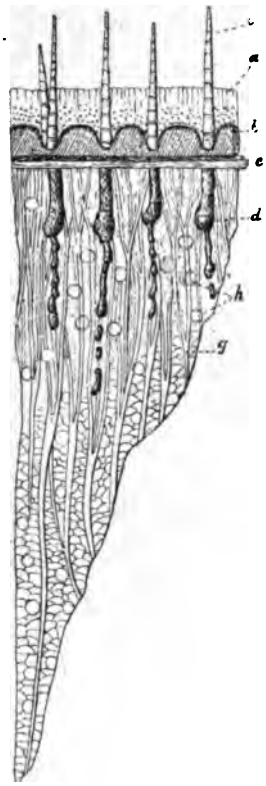


FIG. 101.—Marginal portion of the mantle of *Magellania australis*.
a, margin; *b*, marginal fold; *c*, setæ; *d*, follicles of setæ; *e*, circumpallial muscular belt; *g*, pallial muscles; *h*, bases of pallial cæca.—(HANCOCK).

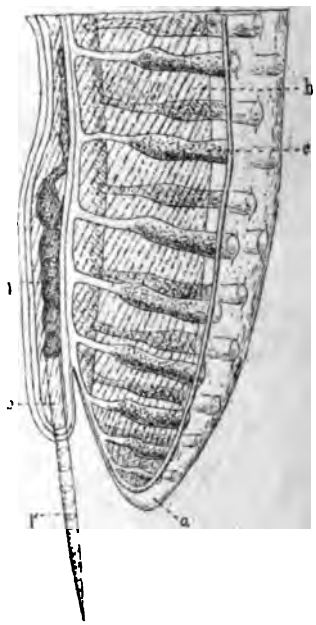


FIG. 102.—Vertical section of shell and mantle of *Magellania australis*.
a, margin of valve; *b*, shell showing prismatic structure; *c*, pallial cæca penetrating shell; *e*, marginal fold of mantle; *p*, one of the setæ; *q*, follicle of the same; *t*, extreme pallial margin.—(HANCOCK.)

In all the larger cavities of the body, including not only the greater sinuses of the mantle but also the perivisceral cavity and the cavernous brachia and cirri, are found calcareous spicules of various shapes which, in some genera, especially THE-

CIDIUM and its allies, unite to form an irregular mass or net-work. It is to a certain degree true that the spicules in a given species or genus have the same general aspect; and while they abound

FIG 103.—*Thecidium mediterraneum*. Interior of the brachial valve; showing the loose spiculization of the shell-substance about the brachia.—(WOODWARD.)

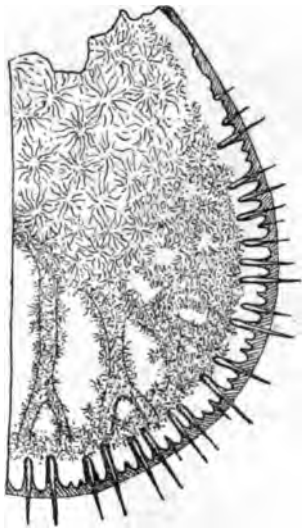


FIG. 104.—Portion of the mantle of *Terebratulina caput-serpentis*, showing spicules.—(HANCOCK.)

in most genera, there are a few (MAGELLANIA, TEREBRATELLA, LINGULA) in which they are absent, or have not been observed. The mantle extends to the edges of the valves and its outer

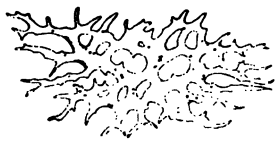


FIG. 105.—Spicules of *Terebratulina*, greatly enlarged.—(HANCOCK.)

margins are thickened, and set with stout chitinous setæ, each of which is lodged in a follicle or sac. The form and exterior of these setæ varies somewhat in different generic groups; in

DISCINISCA their edges are barbed. The function of the setæ seems to have been mainly protective, but in GLOTTIDIA, where they

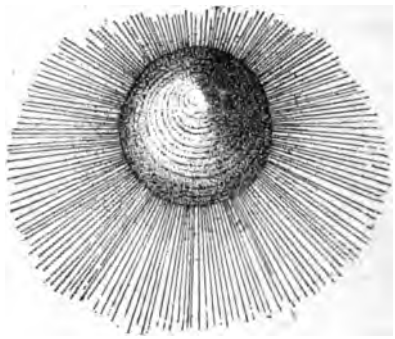


FIG. 106.—*Discinisca atlantica*; showing barbed setæ.— (DAVIDSON.)

are of considerable length, they are said, by MORSE, to be an important aid to locomotion.

THE PEDICLE.

This is the *organ of attachment* to extraneous bodies. In MAGELLANIA and the articulate brachiopods generally, it is a short, stout cylinder, whose inner extremity terminates in, and is attached to the umbonal surface of the pedicle-valve, its outer extremity being protruded through the delthyrium or the foramen in species or stages of growth, where the latter exists. Under other circumstances it may be protruded between the valves, or may be altogether functionless and atrophied at maturity, as is true of the greater part of early fossil species. This organ is a compact, inelastic cylinder of dense muscular tissue. The exposed portion is covered by a thick corneous sheath, and the inner extremity is received into a muscular capsule by means of which attachment to the pedicle-valve is effected. Within the corneous covering is a mass of muscular tissue.

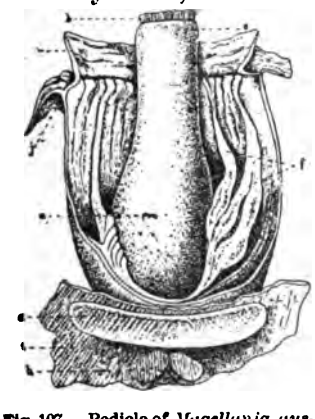


Fig. 107.— Pedicle of *Magellania australis* with capsule laid open. *a*, pedicle; *b*, muscular mass of same; *c*, horny sheath; *e*, margin of orifice leading into capsule; *f*, plications on inner surface of capsule; *g*, pedicle-muscle; *h*, assessory diductors; *i*, wall of perivisceral chamber (pedicle-valve); *j*, same (brachial valve).— (HANCOCK).

ı LINGULA the pedicle is a very flexible, highly muscular
y, often enormously developed in length. At its point of
rgence from the valves, it is exceedingly thick, abruptly
ıracting from this point inward. It is composed of two
rs; an outer, thin corneous one, and an inner muscular one.
organ is traversed for its entire length by a central canal
ch is connected with the chamber inclosing the viscera (*peri-
ral cavity*). The capsule, so highly developed in the tere-
ıuloids is here rudimentary, while the pedicle-muscle is well
eloped. In GLOTTIDIA the pedicle has been shown by MORSE to
ınnulated, supplied with mural pores, and the central canal
e filled by a circulating sanguineous fluid. It has already

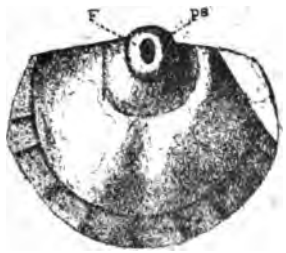


Fig. 108.—*Lepteena rhomboidalis*. A very young shell, x10. F, foramen; *ps*, pedicle-sheath. (BECHER and CLARKE.) For the mature shell see plate 13, figs 2, 3.

Fig. 109.—*Rafinesquina Ulrichi*. An adult shell with the pedicle-sheath highly developed.

ı observed that in *Glottidia Audebardi* the pedicle forms for
f a covering of agglutinated sand grains, etc., being otherwise
ttached, and also possesses the power of contracting itself
ently in all directions. All of these characters are very
gestive of relations to the Annelids, as has been forcibly
ıed by the author quoted.

MUSCULAR SYSTEM.

he Brachiopoda which are articulated by teeth and sockets
open and close their valves only in a vertical plane, and even
his direction the capability of motion is very limited. They
possess, to a limited degree, the power of protruding and
acting the pedicle. We therefore find in the articulate
hiopods *three* sets of muscles, namely: Those which by

contraction open the valves (*diductors*), those which by contraction close the valves (*adductors*), and those which by contraction withdraw the pedicle (*pedicle-muscles*). The arrangement of these is uniformly simple, and the plan is not essentially varied

Fig. 110.—*Lingula Murphiana.* (DAVIDSON.)

Fig. 111.—Extremity of pedicle of *Lingula anatina*, with horny sheath laid open, exposing the muscular cylinder and its membraneous coat. (HANCOCK.)

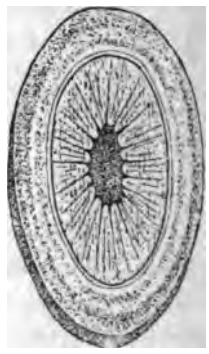


Fig. 112.—Transverse section of pedicle of *Lingula anatina*. (HANCOCK.)

throughout the articulate group. As to the valvular muscles, it is a noteworthy fact that the same muscular action (contraction) produces directly opposite results, on account of the difference in the position of insertion of the muscles of the brachial valve.

Thus, in the pedicle-valve of any living brachiopod like TEREBRATULINA or MAGELLANIA, the principal *diductor* or opening muscles take their origin at the anterior edge of the visceral area and on either side of the axial line. They rapidly diminish in size in

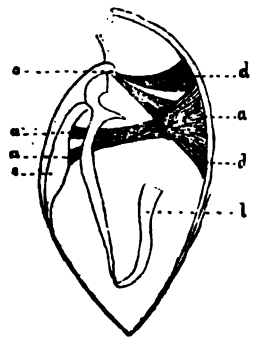


FIG. 113.—Muscular system of *Magellania*. *a*, adductors; *d*, *d*, diductors; *c*, cardinal process; *s*, septum of brachial valve; *b*, brachial supports. (DAVIDSON).

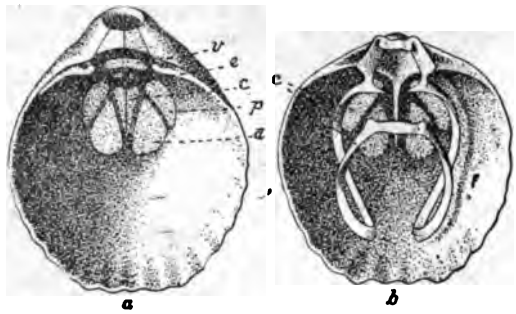


FIG. 114.—*Magellania flavescens*. *a*, pedicle-valve; *b*, brachial valve; *c*, adductor scars; *d*, diductors; *e*, accessory diductors; *p*, ventral pedicle-muscle; *v*, median pedicle-muscle. (DAVIDSON.)

crossing the interior cavity, and their small extremities are inserted on the anterior portion of the cardinal process of the brachial valve. These muscles are, almost without exception, the largest, and leave the deepest scars upon the shell of any in the

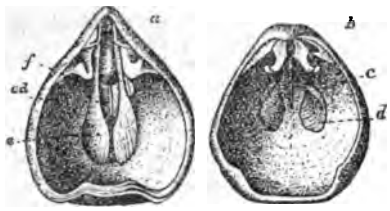


FIG. 115.—*Hemithyris psittacea*. *a*, pedicle-valve; *b*, brachial valve; *c*, posterior adductors; *d*, anterior adductors; *e*, diductors; *f*, pedicle-muscles. (DAVIDSON.)

animal. The reason of this is that the muscles by contraction act upon a very short lever-arm (cardinal process) through which they must overcome the resistance expressed in the weight of the entire body of the brachial valve attached by its posterior

margin. In species where the cardinal process is feebly developed, as in the plicated Spirifers, these muscles were very powerful, as is evinced by the deeply excavated scars they have left; so, also, in ORTHIS (RHIPIDOMELLA) and HIPPARIONYX (Plates 12, 16) the scars may cover a great part of the inner surface of the valve, extending almost to the anterior margin; while in other species where the cardinal process was larger and the leverage more equable, these scars are much feebler and of less size (TRIPLECIA, STREPTORHYNCHUS, STRINGOCEPHALUS; Plates 17, 18). In the posterior part of the muscular region of the pedicle-valve are two much smaller muscular bands (*accessory diductors*, see figure 114) which are inserted on the cardinal process behind the principal diductors. The scars of this pair are very rarely seen among the fossils, and it is doubtful if they existed among the early genera, such as ORTHIS, STROPHOMENA, STROPHEODONTA, etc., where the principal diductors attained such great size.

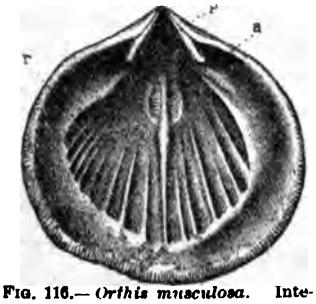


FIG. 116.—*Orthis musculosa*. Interior of a pedicle-valve; *a*, adductors; *r*, diductors; *p*, pedicle-muscle.

The *adductor* or *closing muscles* have a double origin on the pedicle-valve, leaving two elongate scars on either side of the median line, and lying between the scars of the diductors. They traverse the interior cavity almost perpendicularly to the valves, each muscular band dividing, and their insertion on the brachial valve being therefore quadruple. Their divisions on that side of the animal are known as *anterior* and *posterior adductors*. The central position of these muscles gives them a great mechanical advantage in closing the valves and they are therefore less powerful than the diductors; among the fossils they are often obscurely defined. The size and definition of these scars will always be found in direct relation to the amount of work required of the muscles. Thus in STROPHEODONTA and PRODUCTUS their insertion upon the brachial valve is so far back that they are at a disadvantage in moving this valve; and in both of these genera, the scars are usually strong. In

FIG. 117.—Interior of brachial value of *Orthis Vanuxemi*. *j*, cardinal process; *a*, *d*, anterior and posterior adductors.

SPIRIFER, on the other hand, where the mechanical advantage was greater, these impressions on the brachial valve are often scarcely discernible, and, as is often the case among the fossils, the quadruple division of the insertion on this valve is quite obscure.

Besides the valvular muscles, there are *two pairs* and a single *unpaired* muscle which are attached to the *pedicle*. One originates on the pedicle-valve at points just outside and behind the diductors; the other pair is attached to the brachial valve behind the posterior adductors, while the unpaired muscle lies at the base of the pedicle, attaching it closely to the pedicle-valve. Of all these muscles for the retraction of the pedicle, it is only the

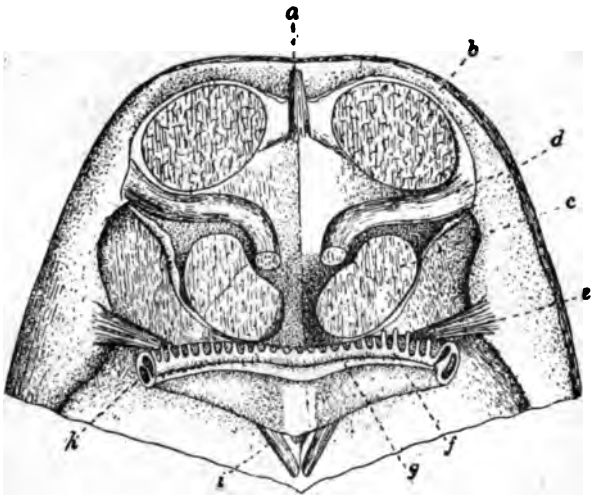


FIG. 118.—The muscular system of *Crania*. *a*, median unpaired muscle; *b*, posterior adductor: *c*, anterior adductor; *d*, protractor; *e*, brachial muscles; *f*, oral surface; *g*, brachial fold; *h*, arm; *i*,=*e*. (JOUBIN.)

unpaired band that often leaves a discernible scar upon the valve, and in numerous fossil species where the pedicle early became atrophied, even this scar is covered by later depositions of testaceous matter. Among some of the inarticulate brachiopods the muscular system is quite as simple as in the articulates. In CRANIA there are *two pairs* of strong muscular bands, the one *median* and close together, the other *posterior* or *cardinal*, and further apart.

The former (*anterior adductors*) close the valves, the latter (*posterior adductors*), by their contraction, *open* the valves to the very limited extent possible among these shells. In addition to

these is a single small pair which is attached to both valves (*protractors* of the free valve), which effects a slight forward and backward movement of the upper valve. Two other small muscular pairs are attached to the brachia, and have their origin on one of the valves (*protractors* and *retractors* of the brachia). There is also a small unpaired muscle originating on the surface of the upper valve, close to the margin and in the median line; this is attached to the viscera, and according to JOUBIN, by

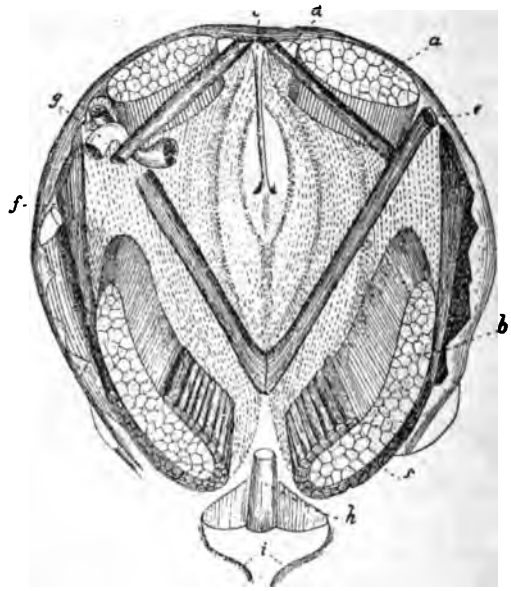


FIG. 119. — Muscular system of *Discinisca*, the muscles remaining attached to the pedicle-valve. *a*, posterior adductor; *b*, anterior adductor; *c*, median unpaired muscle; *d*, posterior protractor; *e*, anterior protractor; *f*, retractor; *g*, intestine; *h*, œsophagus; *i*, arms. (JOUBIN.)

its contraction the passages from the genital organs are opened.

In DISCINISCA the arrangement of the muscles is very similar, there being two pairs, instead of a single pair of *protractors*, which slide the upper or brachial valve outward over the edges of the attached valve, while a single pair of *retractors* draws the valve into place again. There is also here an unpaired median muscle which is probably an organ of retraction of the pedicle.

NGULA and its allies the muscles are more numerous and rrangement far more complicated ı other brachiopods. These ani- ssess the power of separating the in a manner unlike that of other rs of the class; that is, of sliding part laterally or rotating them ı a short arc about the longitudinal the shell. The muscular area s a relatively large portion of the l surface, the bands being arranged the margins of the visceral area. umbonal region there is a central, ed muscle, crossing the interior vertically; this is the *umbonal* or *r* muscle, by its contraction open- e valves along their anterior s.

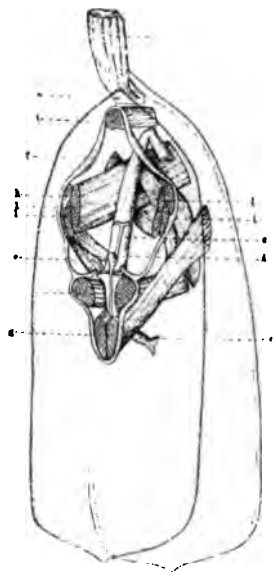


FIG. 120. — Muscular system of *Lingula anatina*: *c*, alimentary canal; *d*, dorsal vesicle; *e f*, walls of perivisceral cavity; *g*, retractors; *h*, adductors; *i*, umbonal; *j k*, protractors; *l*, rotators: *m*, pedicle; *n*, pedicle muscle.—(HANCOCK).

ıdductors (or *centrals*) are a single ıated near the anterior extremity ırea, and they also cross the shell vertically. At the anterior ex- of the area in the pedicle oriğinates a single pair of *protractors* (*middles*), each r of which extends backward and is inserted near the margin of the brachial valve, while a second pair of *tors* (*externals*) originates just behind the adductors of the valve and is inserted behind the first pair. These muscles, r combined action, or independently, draw the brachial orward. The *retractors* (or *anteriors*), or those which t the brachial valve, extend from the outer lateral margins area in the pedicle-valve to its anterior extremity in the l valve. Neither *protractors* nor *retractors* cross the peri- cavity. The *rotators* (*transmedian* or *sliding-muscles*) are ı number, two on one side and three on the other. These ıated posteriorly and cross the perivisceral cavity diago- he undivided muscle passing between the other two. The tion of these, alternately rotates the brachial valve, first in ection and then in the other. In LINGULA, also, the *paries*

or vertical extension of the mantle which incloses the viscera is highly muscular and leaves an impression on the valves. In ancient and fossil forms of LINGULA it is evident that the arrangement was similar to that of living species, and though specimens have been rarely seen which show the muscular scars clearly, a few have been recorded which have retained the scars with great distinctness. In OBOLUS, MICKWITZ finds that, while the general arrangement of the scars is similar to that of LINGULA, the umbonal diductor is simple at its insertion in the brachial valve, and divides in crossing the cavity. This author also ascribes two distinct pairs of scars to the *rotators*, one to the *adductors* and

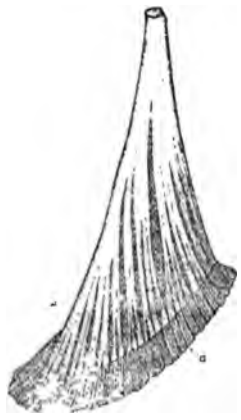


FIG. 121.—Extremity of adductor muscle of *Magellania australis*. *a*, contractile portion; *b*, tendinous portion. (HANCOCK.)

FIG. 122.—Non-striated muscular fibers of *Magellania australis*. (HANCOCK.)

FIG. 123.—Striated posterior adductor or muscular fibers of *Magellania australis*. (HANCOCK.)

another pair which may be either adductors or a third pair of rotators.

There are some differences in the appearance of the muscular bands in the articulate and inarticulate brachiopods, those of the former tapering from origin to insertion, while in the latter they are of more equal thickness throughout. The muscular fibers are smooth, except in the posterior adductor bands where they striated.

ALIMENTARY SYSTEM.

The *mouth* is a simple orifice located centrally at the base of the fleshy brachia. In MEGATHYRIS the oval or buccal area is very broad, but in most brachiopods it is narrowed to a simple groove.

From this point the digestive tube extends backward as a simple bent canal, the flexure being toward the pedicle-valve. In inarticulate species it is much longer and more complicated than in MAGELLANIA, RHYNCHONELLA and the articulates generally. In LINGULA the digestive tube is very long and at the œsophagus is deflected ventrally; the stomach is short, rather more circular than elongate and the intestine makes three or four convolutions; in DISCINISCA and CRANIA there are some variations in the degree of convolution of this tube. In all of the living inarticulated species the intestine terminates in a well-defined *anus*, situated laterally in LINGULA, and in the median line in CRANIA.

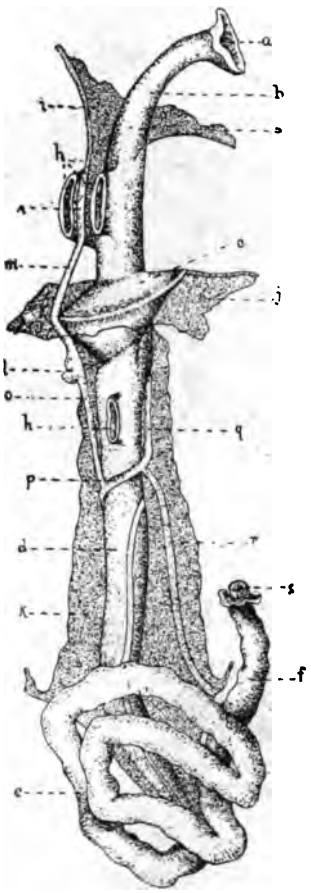


FIG. 124.—Alimentary canal of *Lingula affinis*; *a*, mouth; *b*, œsophagus; *c*, stomach; *d*, intestine; *e*, convolutions of same; *f*, rectum; *g*, anus; *h*, hepatic ducts; *i*, dorsal mesentery; *j*, gastro-parietal bands; *k*, ilio-parietal bands; *l*, dorsal vesicle; *m*, *n*, *o*, *p*, *q*, *r*, blood-vessels; *s*, œsophageal membrane. (HANCOCK.)

In the articulates the alimentary canal is shorter and much simpler than in LINGULA, CRANIA, etc. In MAGELLANIA the *œsophagus* is short, and behind it the tube is slightly contracted, then expanding again into a moderately capacious *stomach*. The *intestine* is short, and toward its posterior extremity makes a single convolution near the hinge-plate of the brachial valve, and it is probable that, in some of the extinct genera, e. g. RENSSELERIA, CENTRONELLA, ATHYRIS, in which this plate is perforated by a central foramen, the intestine passed through it. The posterior end of the intestine is imperforate in all articulated brachiopods, and in MAGELLANIA it is a simple point attached to the *parietes* or lining membrane of the perivisceral cavity. The presence or absence of this terminal perforation is, therefore, of considerable importance in the classification of these animals, and has been made a basis of subdivision by KING, who proposed thereupon the ordinal divisions *Tretenterata* and

Clistenterata (= *Inarticulata* and *Articulata*, respectively). It is believed that in the Articulata the faeces are discharged through the mouth.

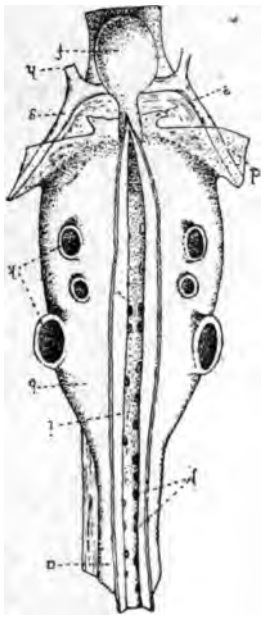


FIG. 125.—Stomach of *Magellania australis*. *a*, œsophagus; *b*, stomach; *d*, *e*, gastroparietal band; *f*, dorsal vesicle; *g*, *h*, blood-vessels; *i*, dorsal blood-vessel laid open, showing (*j*) orifices leading into gastral lacunes; *k*, hepatic ducts. (HANCOCK.)

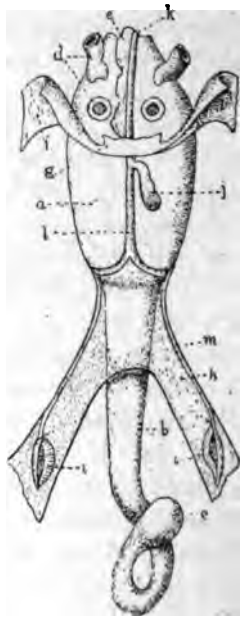


FIG. 126.—Alimentary canal of *Hemithyris psittacea*. *a*, stomach; *b*, intestine; *c*, imperforate extremity; *d*, hepatic ducts; *e*, dorsal mesentery; *f*, gastro-parietal bands; *g*, central band; *h*, ilio-parietal bands; *i*, oviducts; *j*, dorsal vesicle; *k*, *l*, vein; *m*, pallial sinuses. (HANCOCK.)

The entire tube is composed of firm tissue divisible into a fibrous outer coat and an inner mucous lining which is

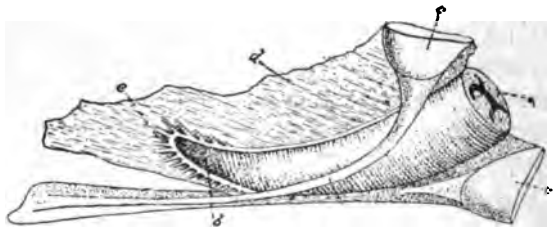


FIG. 127.—Intestine of *Magellania australis*. *a*, upper extremity; *b*, posterior cæca extremity; *c*, portion of oviducts; *d*, ventral mesentery; *e*, thickened ridges of mesentery; *f*, blood vessel. (HANCOCK.)

strongly plaited and wrinkled in the stomach and intestine. Externally it is sheathed by a tenuous membranous coat from

is given off a number of mesenteric bands connecting with alls of the perivisceral chamber. The stomach is usually ped by an ample *liver* of brownish or greenish hue lying

.—The alimentary and muscular system of *Rhynchonella (Hemithyris) psittacea*. *a*, mouth; *b*, œsophagus; *c*, stomach and liver; *e*, imperforate rectum; *n*, pyriform , pedicle-valve; B, brachial valve.

most part on the dorsal side, in the articulates, and on the l side in the inarticulates.

glandular organ is composed of a varying number of ubes terminating in follicles or , and discharging into the h at different points, usually at es. These hepatic canals would o serve in some measure a digesnction, as they have been found ain the food of the animal, and, NCHONELLA, to undergo peristalactions of the tube-walls.

certain series of linguloid genera LOPS, LINGULASMA, TRIMERELLA, here appears to have been a l development of a testaceous ning beneath the insertion of scular bands. This thickening or *platform* becomes slightly ted on its anterior margin in LINGULOPS, more deeply in

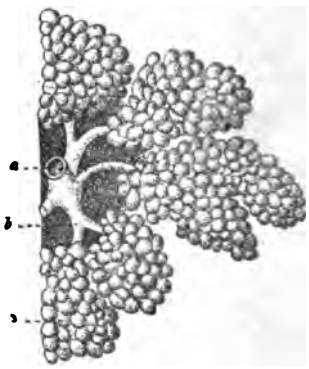


FIG. 129.—A portion of the liver of *Crania*. *a*, hepatic canals; *b*, canal of the lobules; *c*, lobules (JOUBIN.)

LINGULASMA, while in TRIMERELLA and DINOBOLUS the platform is deeply vaulted. The development of these platform vaults does not proceed *pari passu* on both valves, but appears first and is always the deeper on the pedicle-valve. The upper surface of the platform always remains the area of muscular insertion, and it seems highly probable that the vaults have been formed by the necessity for the accommodation of the great hepatic and genital glands; there can be little doubt, at least, that when these chambers are fully developed they are occupied by these organs. A similar feature occurs in an aboloid genus, LAKHMINA, and it is probable that among some of the articulate genera, where the anterior edge of the muscular area is conspicuously elevated (as frequently in *Leptæna rhomboidalis* and *Productus humerosus*) a similar cause has been efficient. Such structures are not to be confounded with excavations of the valves due to the deposition of shell-matter about the ends of the muscles, leaving the scars of the latter deeply sunk, as in many of the Spirifers. (Plates 23–28).

FIG. 130.—*Rhinobolus Davidsoni* Interior of pedicle-valve showing vaulted platform.

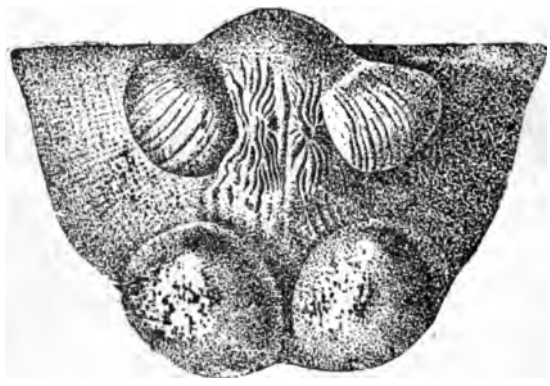
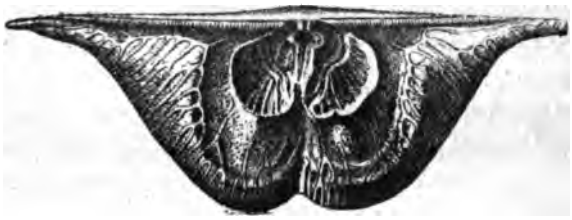


FIG. 131.—Cardinal view of an internal cast of the pedicle-valve of *Productus humerosus*; showing the filling of the great median cavities or vaults, lying in front of the muscular scars. (DAVIDSON.)

CIRCULATORY SYSTEM.

The most striking and most distinctly specialized part of the circulatory system is the series of canals which traverse the mantle, lying within the tissue of the mantle itself. These canals consist generally of two main trunks diverging from the anterior portion of the pervisceral chamber and skirting the margins of the visceral area, giving off secondary branches and ramuscules which are abundantly multiplied at the margins of the mantle. These *pallial sinuses* are frequently so highly developed as to modify the inner surfaces of the valves, and traces of them are often retained

on the latter are fossilized. In SCHIZOPHORIA there a few ple trunks restricted to the median portion of the valves,



. 133.—Interior of pedicle-valve of *Strophonella cælata*; showing muscular impressions and pallial sinuses.

nching only at their extremities; in such shells the lateral ansions of the valves must have been nourished by sinuses too ll to leave their traces on the valves.

134.—Internal cast of brachial valve of *izophoria impressa*. *v*, vascular trunks; enital markings.

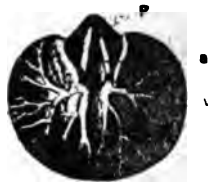


FIG. 135.—*Orthis subcarinata*. [An] internal cast, showing the pallial sinuses; *p*, impression of pedicle muscle; *a*, impression of diduductor muscles; *v*, vascular sinuses.

n CRANIA and CRANIELLA the sinuses are broad, digitate and not ply defined, in the one; sinuous and without apparent nection with the other.

36.—*Crania anomala*: showing the vascular and muscular impressions of attached valve. (DAVIDSON.)

n LINGULA and its allies there are two main trunks which con- ge toward the anterior margin of the valves, and give off not

only an outer but a smaller inner series of branches. The main trunks of the pallial sinuses are the receptacles of a portion of the genital organs, but this fact does not interfere with their circulatory function. Similar canals traverse the fleshy brachia for their entire length. In LINGULA there are three of these lying side by side; one very large and central, a much smaller one at the base of the cilia, the third being lacunary and lying in the brachial fold. In CRANIA and RHYNCHONELLA the last-mentioned of these is absent. All the vascular sinuses pass into the perivisceral chamber and are developed into vesicular dilatations at the back of the stomach and elsewhere. These bodies are not contractile, and their function is at present unknown

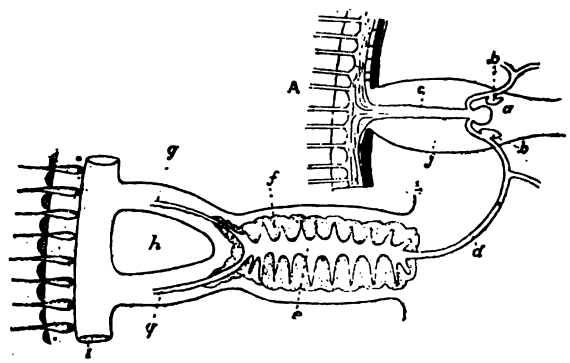


FIG. 137.—A portion of the circulatory system in *Magellania venosa*. Above the right is the ciliated oral surface (*A*), the stomach and intestine (*j*), upon whose dorsal surface is situated a central heart (*a*) sending an aorta (*c*) to the brachia, and giving off two lateral branches, each of which bears a pulsatile sac or subsidiary heart (*b*). The lateral vessels (*d*) supply the genital gland (*f*), and terminate (*g*) within the peripheral lacune (*i*) lying at the base of the setæ (*B*) which border the mantle (*h*). (JOUBIN.)

(HUXLEY). There is no pulsatile vesicle in the animal which performs the function of a heart, and circulation seems to be maintained by means of the ciliated tissue with which the sinuses are lined. Although there is no communication between these vessels and the walls of the perivisceral chamber, it is the opinion of some authors (HUXLEY) that these walls, which are also ciliated, contribute to this function.

In LINGULA, MORSE has observed the existence of caecal extensions of the sinuses or *ampullæ* scattered over the inner surface of the mantle, which are highly contractile and receive and discharge the circulating fluid with perfect regularity.

served by (EHLERT, "the body-walls, the oviducts and the glands are in direct connection with the blood; and the ', the muscles and the liver are enveloped by membranes ute that they can not obstruct the action of the nourishing

RESPIRATION.

unction of respiration has no special organ or set of or its performance; it is not localized, but is evidently wherever the tenuous tissue of the animal with its circu- essels is exposed to the oxygenated water. The mantle ipally concerned in this function, and the long spiral

Lagellania flavescens; showing the brachia. (DAVIDSON.)

FIG. 139. — Extremity of the arm of *Crania*. (JOUBIN.)

undoubtedly contribute, though perhaps not to the extent ed to them by some authors, who have compared them regarded them as branchiæ or gills.

ater entering the brachial chamber of the shells is con- renewed by the opening and shutting of the valves, and more effectively by the constant play of the cilia with ne outer edges of the arms are fringed.

s place a brief account of these arms, their variations and the nature of their calcified supports will be given.

ia. The brachia are labial appendages taking their bout the oral opening and extending in various graceful

curves and spirals into the anterior chamber of the valves. They are two in number, one at each side of the mouth.

These arms are substantially composed of a compact or cartilaginous tissue which is perforated for its entire length by several canals, to which reference has been made in the description of the circulating apparatus. The outer edge of the arms bears the *cirri*, which are kept in motion partly by muscular contraction and partly by the filling and emptying of the brachial canals. At the base of the cirri is a loose membranous expansion or flap, known as the brachial *fold* or *lever*.

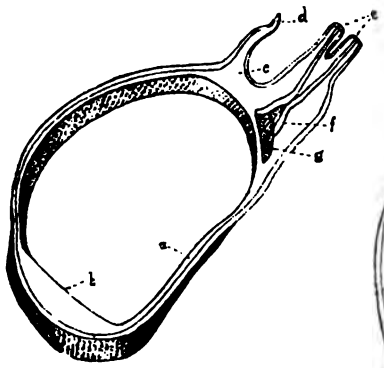


FIG. 140.—Transverse section of arm of *Hemithyris psittacea*. *a*, *b*, wall of great brachial canal; *c*, grooved ridge; *d*, brachial fold; *e*, bases of cirri; *f*, expanded orifices of cirri, opening into canal *g*. (HANCOCK.)

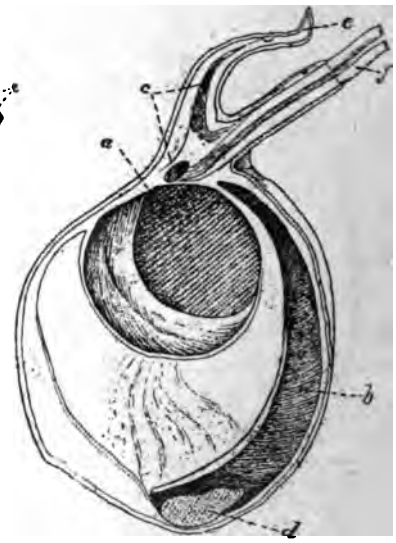


FIG. 141.—Transverse section of arm of *Lingula anatina*. *a*, central brachial canal; *b*, posterior canal; *c*, lacunes; *d*, longitudinal muscle; *e*, brachial fold; *f*, bases of cirri. (HANCOCK.)

In a few of the living genera (LINGULA and RHYNCHONELLA) and in a great number of the extinct forms (SPIRIFER, ATHYRIS, RHYNCHOSPIRA, RAFINESQUINA, etc., etc., and probably ORTHIS) the arms are coiled in long spiral cones, the extremities of which may be directed outward (SPIRIFER, ATHYRIS), inward (RHYNCHONELLA, ZYGOSPIRA), dorsally (ATRYPA), ventrally (AMPHICLINA) or the spirals may be nearly in a vertical (CYCLOSPIRA) or a horizontal (LINGULA) plane; and the number of revolutions in the spiral

aries from two or three (LINGULA, CYCLOSPIRA) to twenty-five *pirifer mucronatus*).

In the majority of living forms (LIOTHYRINA, MAGELLANIA, AGASELLA, MUHLFELDTIA, KRAUSSINA, etc., etc.), the arms extend rward from the mouth or oral disk to the anterior margin of e valves, recurving toward the mouth, and there forming a ort unpaired spiral in the axial line. While these are the incipal variations in the arrangement of these parts, a notable fference is presented by EGATHYRIS, THECIDIUM id their allies, in the com- ete attachment of the m to the brachial valve r its lower margin. ne area thus inclosed the brachia is fre- iently large (*Megathyris collata*) and it may be vided on its outer margin into three or more deep lobes. ving species whose brachia do not rest upon solid, lcified supports may possess the ability to uncoil and protrude e brachia between the open valves. This has been observed in

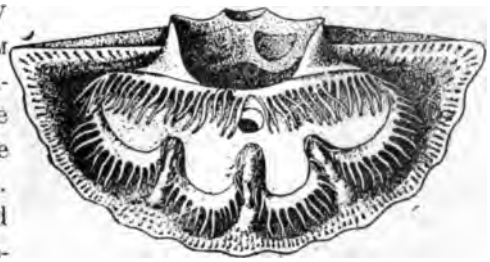


FIG. 142.- Brachial valve of *Megathyris decollata*, showing the arms attached by their lower margin about the expanded oral disk. (WOODWARD.)

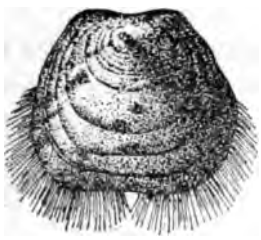


FIG. 143.-*Crania anomala*, with arms extended. (DAVIDSON.)

FIG. 144. — *Hemithyris psittacea*, with arm extended.

RYNCHONELLA (OWEN, MORSE), though it is doubtful if it is pos- le to the animal of LINGULA. In *Terebratulina caput-serpentis*, ich possesses a short, solid brachial support, the animal can tend only the outer free margins of the arms and then but for ery short distance (BARRETT).

The ability of the brachiopods to form calcareous supports for the brachia may be regarded as degenerate in living species. Among extinct species, especially those belonging to the later Palæozoic and earlier Mesozoic eras, are to be found delicate and often exceedingly complicated supports, which were probably continuous with the fleshy arms for the entire extent of the latter. In SPIRIFER, for example, long spiral cones consisting of many revolutions of an exceedingly tenuous calcareous ribbon are frequently preserved with the utmost delicacy, and in

FIG. 145.—*Terebratulina caput-serpentis*, with arms extended. (BARRETT.)

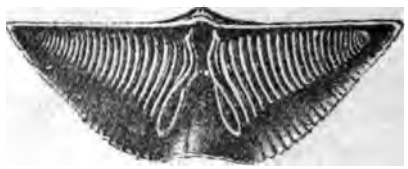


FIG. 146.—*Spirifer mucronatus*. Interior of brachial valve, showing spirals.

KAYSERIA, AMPHICLINA and some forms of ATHYRIS from the St. Cassian beds, these spirals are accompanied by an accessory pair, making four in all. The mode of union of these parts, their attachment to the valves and to the various supporting septa, are features of much significance, while the delicacy of such structures renders the determination of these points of great intricacy and difficulty.

Such calcareous supports, which in any individual are known as the *brachidium*, are formed by the interlocking and cementation of the spicules which are disseminatedthrough the canals and cirri of the brachia. The recent brachio pods possess only simple lamellar extensions which, in TEREBRATELLA, MAGELLANIA, LIOTHYRINA and TEREBRATULINA consist of two lateral processes. These may be united at their anterior extremity (LIOTHYRINA, TEREBRATULINA), or reflexed anteriorly, the union of the branches being median or posterior (MAGELLANIA, TEREBRATELLA.

FIG. 14. Interior of brachial valve of *Liothyrina vitrea*. *c*, cardinal process; *g*, brachial supports. (DAVIDSON.)

In all these cases the simple apparatus corresponds to only a portion of the first revolution of the ribbon in SPIRIFER, RHYNCHOSPIRA, etc.

The size of the spiral cones and their direction varies to a certain degree equably with the form of the interior cavity of the valves. In species of SPIRIFER with greatly extended hinge-line the cones are very long and are directed toward the cardinal angles; where the hinge is short (MARTINIA) and its lateral angles rounded the cones are short or placed at oblique angles. In MERISTA, ATHYRIS, RHYNCHOSPIRA, MERISTINA, etc., etc., the axis of the spirals lies in the greatest transverse diameter of the shell. In ATRYPA the two flattened cones lie side by side, and their apices are directed into the cavity of the deep brachial valve.

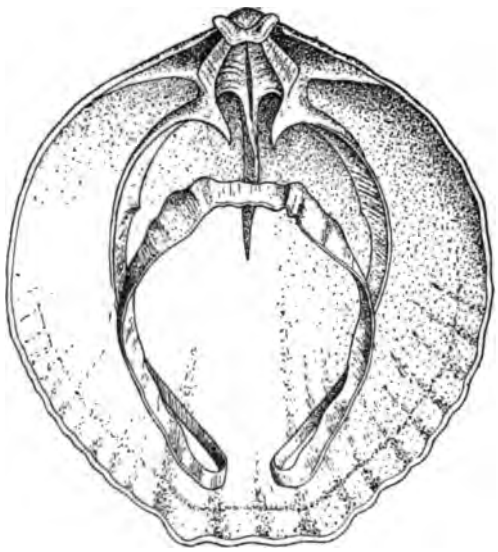


FIG. 148.—The brachial supports of *Magellania australis*. (HANCOCK.)

The brachial supports are attached to the hinge-plate, or apical portion of the brachial valve, by two processes termed *crura*. The precise termination of the crura and the commencement of the spiral ribbon is often obscure, but is frequently indicated by a sharp angle at the point of union and an abrupt widening of the ribbon directly behind it. (NUCLEOSPIRA, RHYNCHOSPIRA.) From this the curvature of the ribbon is downward into the cavity of the brachial valve, and the extensions of the ribbon for the first one-half revolution are termed the *primary lamellæ*.

In SPIRIFER the crura are very long, the bases of the spiral cones in this genus being small and situated well forward. The pri-

mary lamellæ are usually broader and stronger than the remainder of the coil and may be preserved in the fossil state when the rest is lost. These lamellæ, near the middle of their length, give off a pair of simple laminar processes which extend upward between the bases of the cones, and usually unite. When these processes thus unite the body formed is termed the *jugum*;* when they do

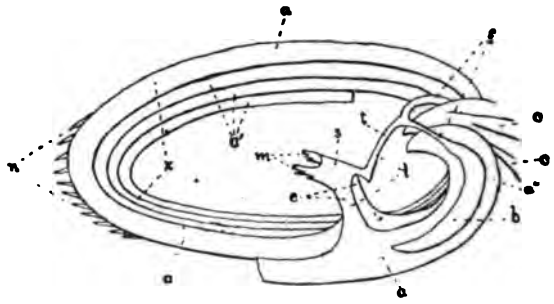


FIG. 149.— Diagram of loop and spiral *Athyris*; *x*, spiral; *a*, primary lamellæ; *a*, secondary lamellæ; *a''*, umbonal blades; *c*, crura; *l*, jugum; *e*, lateral branches of jugum; *s*, saddle; *m*, fimbriated extremity; *t*, stem of jugum; *f*, branches of jugum; *b*, intercalary lamellæ; *n*, fimbriæ on outer edges of spiral.

not unite, as in SPIRIFER, they may be called the *jugal processes*.

The function of this jugum is, unquestionably, in part to strengthen the entire apparatus and resist the strains to which

FIG. 150.— *Zygospira modesta*. The brachidium exposed by the removal of the brachial valve, showing the jugum.

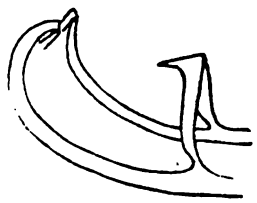


FIG. 151.—Jugum of *Trematospira multistriata*, attached to a portion of the primary lamellæ.

the cones are exposed from gravitation and other causes. It is therefore remarkable that SPIRIFER, in which the cones reach

* This organ has usually been termed the *loop*, but the use of this term among the brachiopods with calcified spirals causes obscurity and confusion, as the word was originally applied to the entire brachial support in the terebratuloids, and it must continue to be used with this meaning while the relations of the true *loop* to the *jugum* of spire-bearing shells is that of a whole to a part.

their greatest development, is always devoid of this support, and equally noteworthy that this genus, which seems poorly adjusted against such strains when compared with other spire-bearing

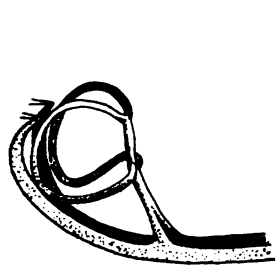


FIG. 152.—Jugum of *Meristella arcuata.*

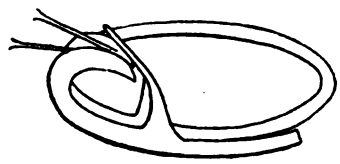
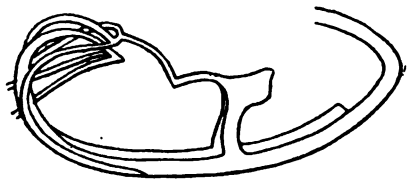


FIG. 153.—Jugum of *Nucleospira ventricosa.*

genera, should have maintained so long and so prolific a development without variation in this respect.

The jugum does not end at the point of union of the two lateral jugal processes, but is more or less continued, in its



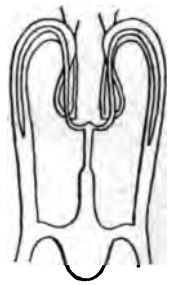
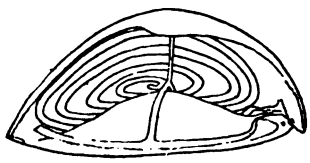
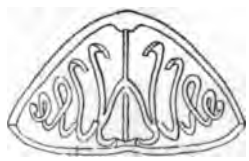


FIG. 154.—Jugum of *Athyris vittata.*

simplest form, into a short, straight stem, inclined backward and terminating in an acute angle (RETZIA, RHYNCHOSPIRA, WHITFIELDELLA); in BIFIDA this stem is long and extends to the inner surface of the pedicle-valve where its extremity is inserted into a deep groove in the shell. In EUMETRIA and MERISTINA the





Brachial apparatus of *Bifida lepida.*

FIG. 155.—Longitudinal section. FIG. 156.—Transverse section.

extremity of the stem is bifurcate, but the terminal processes do not extend beyond the ends of the crura; while in ATHYRIS,

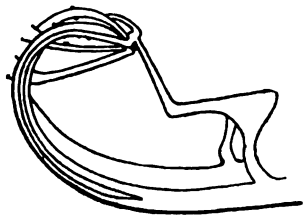


FIG. 157.—Jugum of *Athyris spiriferoides.*

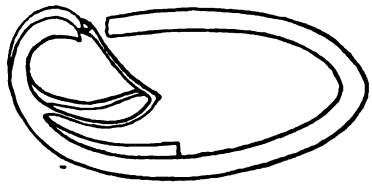


FIG. 158.—Jugum of *Eumetria Verneuiliana.*

TETRACTINELLA and AMPHITOMELLA they are continued backward between the primary and secondary lamellæ for about one fourth

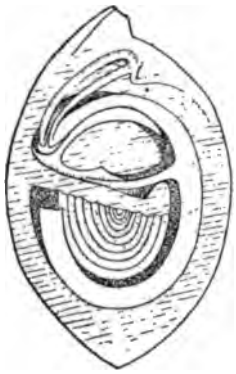


FIG. 159.—Loop of *Tetractinella.* (BITTNER.)

FIG. 160.—Loop of *Amphitomella.* (BITTNER.)

of a revolution. In PEXIDELLA the intercalary lamellæ are still longer; in AMPHITOMELLA, KAYSERIA and AMPHICLINA they are

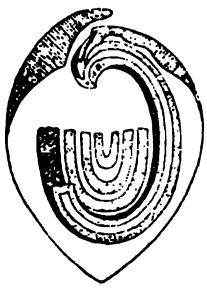


FIG. 161.—Loop of *Pexidella.* (BITTNER.)

FIG. 162.—Loop of *Diplospirella.* (BITTNER.)

continued for the entire length of the spiral cones thus making a double spiral on each side. In MERISTA and MERISTELLA the

divisions of the stem of the jugum, or intercalary lamellæ, are short, recurving and joining the lateral processes near their union.

This place of union of the lateral branches of the jugum is frequently somewhat thickened and expanded (RETZIA, RHYNCHOSPIRA, UNCITES) and in ATHYRIS it is a broad, saddle-shaped structure.

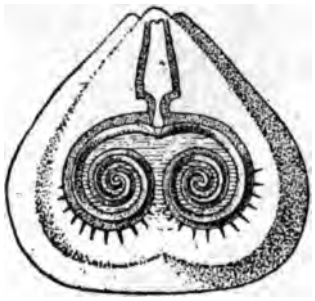


FIG. 163.—Brachial apparatus of *Koninckina*, showing the double spirals. (BITTNER.)

In the last genus the posterior margin of this *saddle* is sometimes fimbriated, and not infrequently similar fimbriæ or spinules are retained on the outer posterior edges of the primary and second-

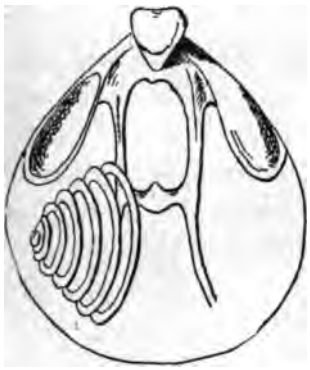


FIG. 164.—Loop and spiral of *Uncites gryphus*. (DAVIDSON.)

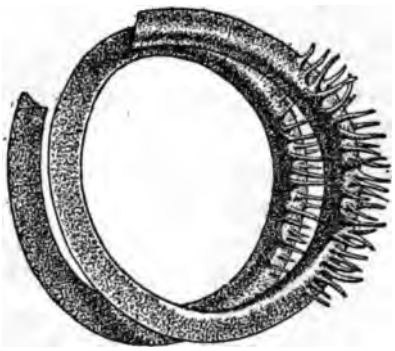


FIG. 165.—Portion of spiral of *Spiriferina rostrata*, showing the fimbriæ on the outer margins of the coils. (DAVIDSON.)

-ary lamellæ; these have also been observed in ATRYPA, AMBOCOELIA, DAVIA, etc. These spinules undoubtedly result from the network of spicules deposited in the cirri of the brachia.

The jugum is often in close relation with the median septum of the brachial valve. Perhaps in no case among the spire-bearing species is there an actual union of these parts, such as

is so frequent among the terebratuloids; but in several genera, MERISTINA, KAYSERIA, BIFIDA, a high median septum rises so close to the angle of the jugum that but a very slight depression of the

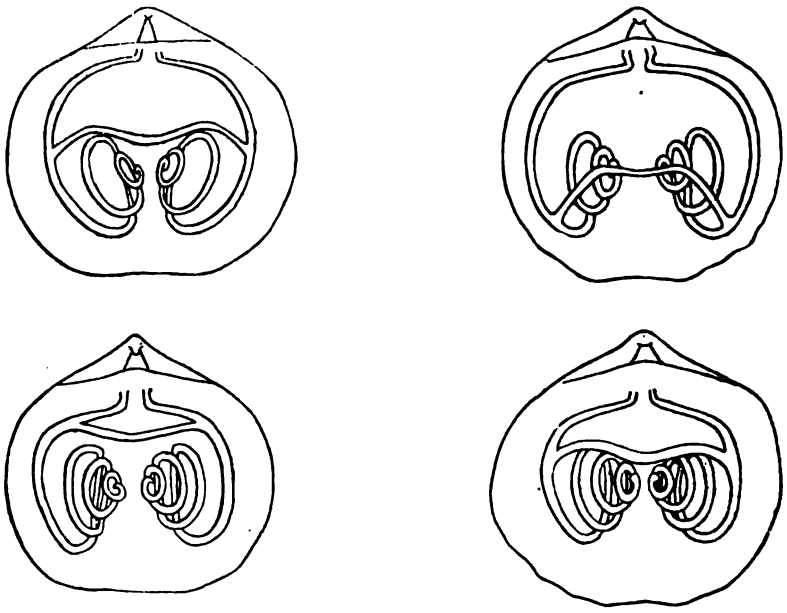


FIG. 166.— Brachial apparatus of *Zygospira modesta*, showing the variation in the position of the jugum.

entire brachial apparatus would cause it to rest upon the septum and thus secure an efficient support. Whether this septum has been at all concerned in the modifications to which the spirals

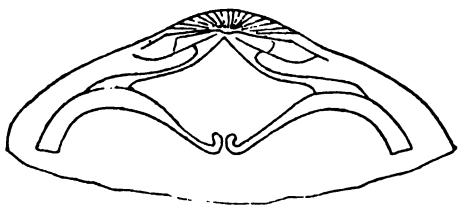


FIG. 167.— Jugal processes of an adult *Atrypa reticularis*.

have been subjected in growth has yet to be determined. In genera, where the spirals are convergent rather than divergent, ATRYPA, ZYGOSPIRA, GLASSIA etc., the jugum is always simple in

its structure. ATRYPA, with its spirals directed upward into the cavity of the brachial valve, has its jugum situated posteriorly and is composed of two lateral branches directed anteriorly, and slightly upward in the middle. In early growth-stages this is a

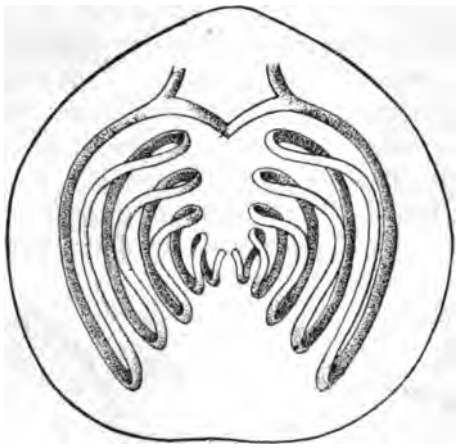


FIG. 168.— Brachidium of *Glassia obovata*, showing the posterior position of the loop. (DAVIDSON.)

continuous band, but in mature or senile conditions of growth it becomes divided in the middle (probably from the lateral strains to which it is subjected) and the extremities of the jugal processes become much thickened. In GLASSIA the spirals have their apices

FIG. 169.— Brachial valve of *Megerlia truncata*. *g*, loop; *l*, septum. (DAVIDSON.)

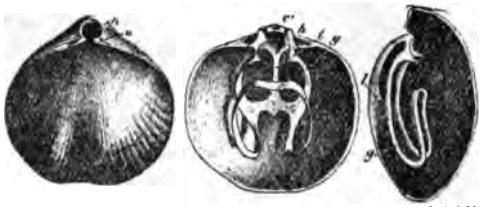


FIG. 170.— *Terebratella dorsata*. *n*, foramen; *o*, deltidial plates; *c'*, cardinal process; *h*, hinge-plate; *l*, septum; *g*, brachial supports. (SUESS.)

at the center of the internal cavity and their bases at the sides; the jugum is a short posterior transverse band. In ZYGOSPIRA the variation in the position of the jugum in a given species (e. g., *Z. modesta*) is remarkable, it being sometimes posterior, at

others median, and again anterior, curving forward in the first case and backward in the last.

In the non-spiriferous brachiopods, or those in which the brachial apparatus is abbreviated, we usually find a simple representation of the primary lamellæ and the jugum which may be variously complicated with the median septum of the brachial valve. In this group the entire calcified apparatus is termed the *loop*, which is typically composed of two long or short primary or *descending lamellæ* which may recurve more or less profoundly at their anterior extremity (*ascending lamellæ*,) and unite in a transverse band. This last is the homologue of the jugum. In TEREBRATELLA, TEREBRATALIA, MÜHLFELDTIA, ISMENIA, and some other genera, the descending lamellæ are united to the median sep-

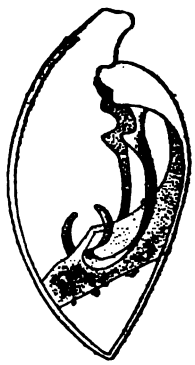


FIG. 171.— *Terebratalia dorsata*. (WOODWARD.) FIG. 172.— *Magasella Cumingi*. (DAVIDSON.)

tum by a dorsal band, which is a residuum resulting from progressive resorption of the calcareous parts, and wholly disappears in more advanced forms, such as *Magellania venosa*. In typical forms of MAGELLANIA the septum also has disappeared and the loop in the adult condition is without any evidence of former connection with the valve, except at the hinge-plate. A corresponding adult condition is found in the palæozoic genera CRYPTONELLA, MEGALANTERIS DIELASMA, etc. In CENTRONELLA and RENSSELAERIA the primary lamellæ simply unite at their anterior extremities without reflection, the apparatus here being expanded into a triangular plate. A somewhat similar arrangement is seen in MAGAS and PLATIDIA, while in BOUCHARDIA, KRAUSSINA, little is left of the brachial sup-

ports but the median septum and the portions of the loop attached to its anterior extremity.

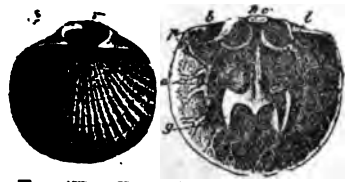


FIG. 173.— *Kraussina rubra.* *n*, foramen; *hc*,' cardinal process; *a*, *b*, adductors; *p*, pallial sinuses; *g*, brachial supports; *l*, septum. (DAVIDSON.)

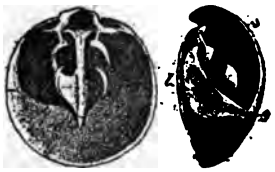


FIG. 174. — *Magas pumilus.* *b*, median septum; *g*, brachial supports. (DAVIDSON.)

Of Palæozoic genera TROPIDOLEPTUS alone has afforded evidence of actual connection in the mature state of the descending lamellæ

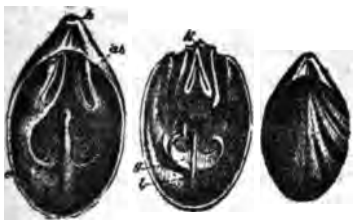


FIG 175.— *Bouchardia rosea.* *h*, foramen; *ab*, adductors; *e*, diductors; *k*, cardinal process; *g*, brachial supports; *l*, septum.

FIG. 176. — Brachial valve of *Platydia anomioides.* *g*, loop; *l*, median septum. (DAVIDSON.)

with the median septum, a condition of the brachial apparatus comparable to that of PLATIDIA among living forms.

In many of the terebratuloids the union of the crura and primary lamellæ is represented by sharp crural angles directed inwardly. In LIOTHYRINA, which has the entire supporting apparatus remarkably abbreviated, these angles are conspicuous, while in TEREBRATULINA they unite to form a continuous band. In the Devonian genus STRINGOCEPHALUS, the crura are very long, the loop absent, and the lamella very broad and situated just within the margin of the brachial valve; from it extends a series of filamentous processes, which are directed towards, and may have been attached to the crura.

FIG. 177. — Muscular and brachial apparatus of *Stringocephalus Burtini.* *a*, adductors; *b*, diductors; *c*, cardinal process; *d*, brachial support. (HOERNES.)

The species in which the lower surface of the brachia is attached

FIG. 178. — *Megathyris decollata*. *n*, foramen; *o*, deltidial plates; *g*, crura; *l*, lobed extension of brachial supports. (BRONN.)

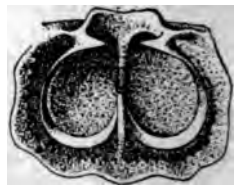


FIG. 179. — *Cistella neapolitana*. Interior of brachial valve. (WOODWARD)

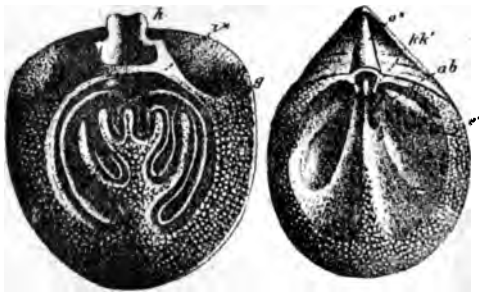


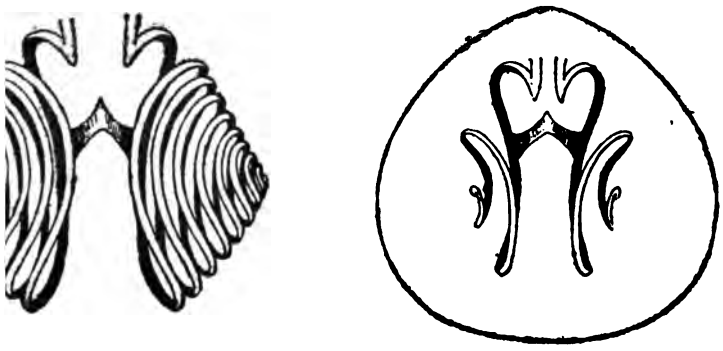
FIG. 180.— Interior of brachial and pedicle valves of *Thecidium radiatum*. *o'*, deltidium; *kk'*, teeth; *ab*, adductors; *e'*, diductors; *h*, cardinal process; *i'*, cardinal plate; *g*, brachial supports. (SUESS.)

to the mantle, have a simple vertical lamella (CISTELLA), which may be lobed (MEGATHYRIS, BACTRYNIUM, EUDESELLA, DAVIDSONELLA, etc.). In THECIDIUM, THECIDELLA, LACAZELLA, etc., the definition of the lamella is obscured, the spicular network being loose and sponge-like. The brachiopods which were not possessed of elaborate brachial supports may have long calcareous crura, as in RHYNCHONELLA and its allies, or even these may be wanting, as in STROPHOMENA, PLECTAMBONITES and PRODUCTUS. Such shells, however, sometimes retain grooved impressions made by the spiral arms upon the inner surface of the valves (DAVIDSONIA, RAFINESQUINA) In CHONETES and PRODUCTUS there are two divergent impressions on the brachial valve, which are commonly known as the *reniform markings*, and these are generally regarded as due to the brachia, though their precise relation to these organs has not been satisfactorily explained.

FIG. 181. — The interior of the pedicle-valve of *Rafinesquina Jukesi*, showing the impression of the spiral arms. (DAVIDSON.)

ı the mode of development and growth of the brachia and
ːing apparatus some important observations have been

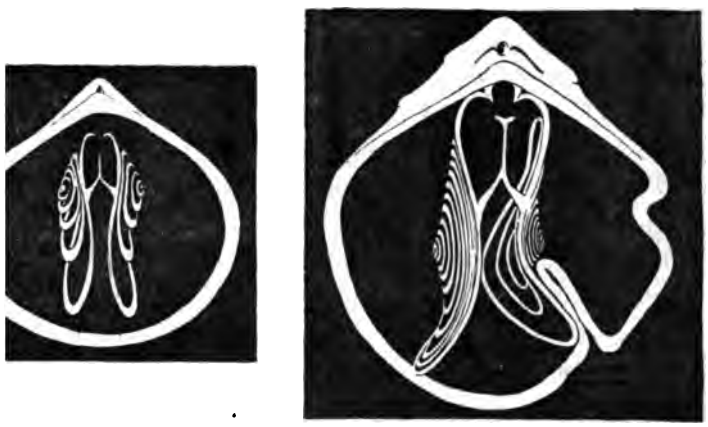
ɜE has shown that in early stages of TEREBRATULINA the
re simple or double horse-shoeshaped processes, quite like



Rhynchospira (*Homœospira*) *evax*.

—The mature condition of the brachidium.
—The brachidium in a very early stage of growth; in this figure the form of the wholly constructive. (BEECHER and CLARKE.)

hophore of the Bryozoa. The same author also demon-
that the formation of the crura and brachial supports is a



Meristina Maria.

The brachidium in a very
ition of growth: showing the lax
s of the ribbon and the depressed
es.

FIG. 185.—The brachidium in a young shell, showing a distortion in one of the spirals caused by an obstruction to the peripheral growth on one side of the valves, which has apparently produced no disturbance of function in the brachia.

l and permanent accretion, growth taking place on both
ntil union is effected and the support thus completed.

Among the spire-bearing forms it has been shown that in the young of *Rhynchospira* (*Homœospira*) *evax* the ribbon is very slender and makes but a few and very lax revolutions. The same fact is evident in the young of *Meristina Maria* (as shown in the accompanying figures), where the revolutions are few and the spiral cones depressed. The growth of these solid bodies and the increase in number of the revolutions could be effected only by constant resorption and redeposition of the spicular calcareous secretions from the brachia.

KOVALEVSKI, FRIELE, DESLONGCHAMPS, EHLERT, BEECHER and others have given accounts of the development of the brachia in CISTELLA and some of the higher genera of the *Terebratellidæ* (TEREBRATELLA, MAGELLANIA, MACANDREVIA, DALLINA, TEREBRATALIA). In the early stages of such shells the brachia have the form of a circlet, extending forward from about the mouth, bearing a few tentacles or cirri, which are directed inwards. This condition is comparable to the adult condition in GWYNIA and has therefore been termed the *gwyniform stage*. By the development of a median septum in a succeeding stage of growth this circlet becomes inflected medially and the resultant condition is that of the adult CISTELLA (*cistelliform stage*). With the further growth of the septum and the development of its lateral processes the brachia gradually take on the form of the mature PLATIDIA (*platidiform stage*), the cirri finally becoming everted, and the median unpaired arm resulting from the continued growth of the basal cartilage and the multiplication of the cirri at the distal extremities of the brachia.

These developmental stages are still more clearly exemplified in the formation of the loop or calcareous supports. Among the *Terebratellidæ* there is one group of boreal forms (*Dallininæ*) and one also of austral forms (*Magellaninæ*), all agreeing in having the loop, in its final condition, composed of long descending and ascending branches in no connection with the median septum. In the boreal forms (MACANDREVIA, DALLINA) the development of the loop has passed through a series of stages corresponding successively with the adult condition in PLATIDIA, ISMENIA, MÜHLFELDTIA and TEREBRATALIA, while in the austral group (MAGELLANIA) the preliminary stages are reproduced in the adult KRAUSSINA, Bou-

CHARDIA, MEGERLINA, MAGAS, MAGASELLA and TEREBRATELLA, successively. The larval conditions of the terminal members of both series are similar to the adult condition of the simplest members of the family, CISTELLA and GWYNIA.

Thus similar resultants have ensued in this family by progressive growth and resorption of the brachial supports through quite dissimilar lines of development.*

From the study of young stages in a Carboniferous species, *Dielasma turgida*, a terebratuloid with short, recurved loop, and in the Silurian species, *Zygospira recurvirostra*, a spire-bearing shell with introverted cones, it has been demonstrated† that in the earliest observed conditions of both, the brachidium consists simply of the two lateral or descending lamellæ, united in front, forming an expanded triangular plate like that in CENTRONELLA and RENSSELAERIA.

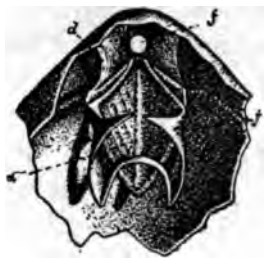


FIG. 186.—*Dielasma elongatum* *f*, foramen; *j*, jugal processes; *d*, dental plates; *m*, muscular impression.—(DAVIDSON.)

Resorption of the anterior portion of this plate gradually produces the ascending and transverse lamellæ of DIELASMA and the jugum of ZYGOSPIRA; parts which are thus seen to be alike in origin and function. With DIELASMA the process here ceases, but in ZYGOSPIRA there is a continuation of the lamellæ carried forward from the ante-lateral angles of the loop, which, with growth takes on the spiral form of the mature brachia. The inference from this evidence is that the CENTRONELLA-loop is of the simplest type; anything more elementary would represent the condition of the descrete crural processes in RHYNCHONELLA. The recurved loop of the terebratelloids is a more advanced condition of this organ, while the spiral brachidium, attained so abundantly and with such diversity, during Paleozoic and early Mesozoic time, represents its most elaborate development.

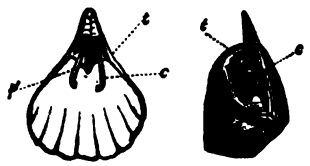


FIG. 187.—*Rhynchotreta cuneata*: showing the crural processes.

* These interesting facts have been established by the investigations of FRIELE, OEHLERT, FISCHER and C. E. BEECHER.

† BEECHER and SCHUCHERT; Proceedings of the Biological Society of Washington, vol. VIII. 1893.

THE NERVOUS SYSTEM.

The nerve-collar surrounding the œsophagus constitutes the principal nerve mass in the Brachiopoda. In the articulate species there is a large ganglion (subœsophagian) on one side of

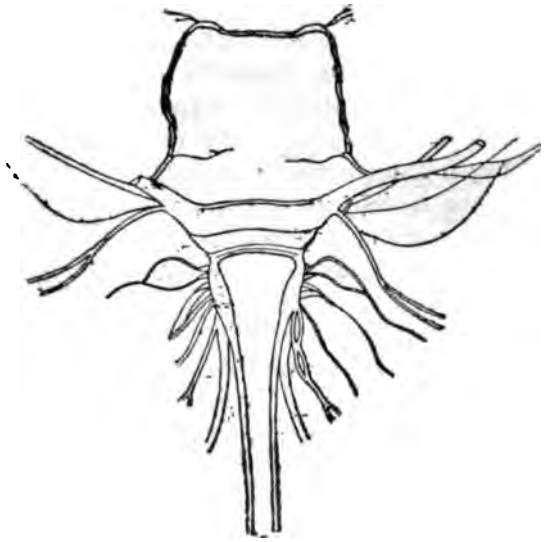


FIG. 188.— Œsophageal ganglion of *Magellania cranium*. (HANCOCK.)

the œsophagus, connected by fine lateral commissures with a smaller ganglion on the opposite side. In the inarticulates (LINGULA, CRANIA) so far as ascertained, the upper and lower ganglia are not so well developed, the nerve-ring being of more equal size throughout. From the swellings of the œsophageal rings, nerve-fibers are given off to the brachia, muscles, and the two lobes of the mantle. It would appear that the nervous system as a whole is more highly developed in the articulate than in the inarticulate brachiopods. It has not been demonstrated that the adult

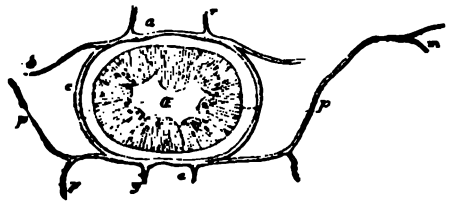


FIG. 189.— Nervous system of *Crania*. œ, œsophagus in section; *c*, collar; *a*, cerebroid ganglion; *n*, brachial nerve; *e*, subœsophageal ganglion; *g*, inferior nerve; *p*, dorsal pallial nerve; *p*, ventral pallial nerve; *m*, nerve of muscles. (JOUBIN.)

chiopod possesses any *organs of special sense*, but in the ɔryos of several genera, bodies believed to perform such funcıs have been observed.

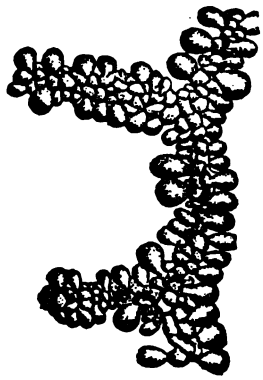
ɜROOKS has shown the existence of an auditory organ in *Lingula*, ilar to that of the lamellibranchs, viz.: a pair of otocysts conıing vibratile otoliths, which are situated close to the nerve ar.

ɨimilar structures were observed in DISCINISCA by MÜLLER. ɜ very young of THECIDIUM, CISTELLA and DISCINISCA bear two or r minute pigment spots on the cephalic segment, which are ɨeved to be organs of vision. All trace of these sense organs esorbed in later growth.

THE REPRODUCTIVE SYSTEM.

t has already been observed that the brachiopods, so far as ɔwn, not only reproduce by ova, but are also dicecious. It is

.90.— Oviduct of *Hemithyris psittacea*, aminated portion; *b*, tubular portion; rinkles of lining membrane; *d*, external ning; *e*, vesicle; *f*, *g*, blood-vessels. ANCOCK.)



.FIG. 191.— Fragment of ovary of CRANIA. (JOUBIN.)

cult, however, to distinguish the male from the female animal, ɜpt upon the approach of fecundity. Then the testes become ɨrged by the colorless spermatic fluid, and take on a pale hue; ɜhe other hand, as the ovaries of the female become crowded

with eggs, the slight color of the latter deepens the tint of the entire organ.

The location of both male and female reproductive glands is essentially the same. Generally they are found to occupy the main trunks of the vascular sinuses though they may extend into the visceral chamber, and, in some of the inarticulate genera (LINGULA, DISCINISCA), be restricted to the latter. When in the pallial sinuses, though attached to the upper and inner wall of the mantle, they frequently leave a lobed or pitted impression upon the shell, which is retained after the shell is fossilized.

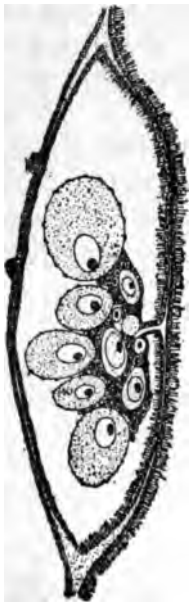


FIG. 192.— Section of ovary of *Crania*, showing the suspended ova in various conditions of development. (JOUBIN.)

The discharge of the genital products is effected by two or four tubular organs or funnels, which have been described by some authors (OWEN) as hearts. These trasverse the wall of the perivisceral chamber and open outward into the pallial cavity. Their inner openings are large, expanded orifices, abundantly plaited, and separated by a constriction from the narrower part. Ova have been seen to pass through these organs (MORSE) to which they are drawn by the action of the cilia covering their surface. HUXLEY considers that these funnels also subserve the function of renal organs and that they are homologous to the *organs of Bojanus* in the mollusca, and to the segmental organs of the annelids.

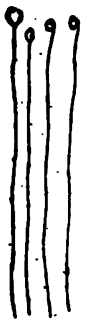


FIG. 193.—Spermatozoids of *Crania* much enlarged. (JOUBIN.)

It is generally believed that fecundation takes place after the discharge of the eggs into the pallial chamber or into the sea water. An interesting condition of fecundation occurs in LACAZELLA and CISTELLA, which compels the conclusion that the spermatozoids have penetrated from without into the visceral chamber and there fertilized the eggs.

A fold is formed by an expansion of the mantle, which incloses a number of fertilized eggs, attached to two very large brachial

irri, and while in this condition the segmentation of the embryo is effected. It is not known at precisely what stage of development these embryos are set free from the suspensory cirri and emitted into the outer chamber of the valves.

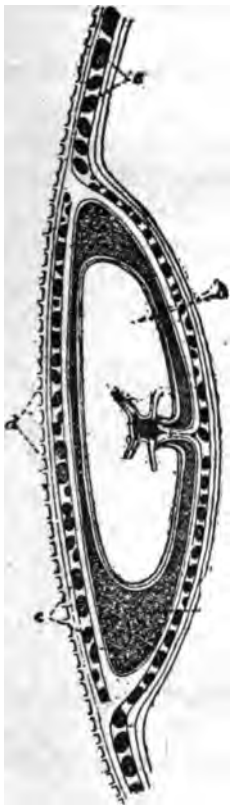


FIG. 194—Transverse section of mantle of *Magellania australis*. *a*, pallial sinus; *b*, genital organ; *c* pallial lacunes; *d*, bases of pallial caeca. (HANCOCK.)

In a specimen of *Lingula lamellata* from Upper Silurian, of Hamilton, Ontario, the pallial cavity has been found filled with ova; and EHLERT cites a specimen of STRINGOCEPHALUS (Middle Devonian) in whose valves were found a number of embryo shells, which would indicate that development had taken place in this chamber. An accelerated growth of the reproductive organs and the perfection of their function is shown in certain species of TEREBRATELLA, which are capable of reproduction during the adolescent *magaliform* and *magaselliform* stages, thus perpetuating a more primitive race which does not attain the characters of the adult TEREBRATELLA.

FIG. 195—Embryo-pouch of *Lacazella* partly broken, exposing clusters of segmented embryos attached to the suspensory cilia (LACAZE-DUTHIERS.)

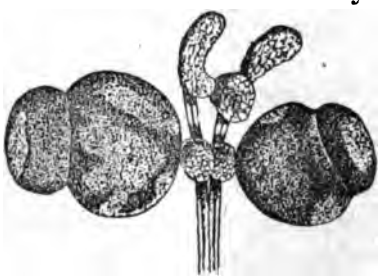


FIG. 196—Two embryos of *Lacazella* attached to the suspensory cilia. (LACAZE-DUTHIERS.)

DEVELOPMENT.*

From the fertilization of the *ovum* to that stage which may be regarded as terminating the embryonic period, the developing brachiopod passes through the conditions of

* Our knowledge of the embryogeny of the living brachiopods is due to OWEN, HANCOCK, DAVIDSON, MORSE, KOVALEVSKI, LACAZE-DUTHIERS, MÜLLER, SHIPLEY and BROOKS, and is pretty much restricted to the genera TEREBRATULINA, LIOTHYRINA, CISTELLA, LACAZELLA and GLOTTIDIA. The most important contributions upon the morphogeny of the brachiopod shell, are those of C. E. BESCHER.

(1) *Protembryo;* unsegmented and segmented stages, before the formation of a primary internal cavity (blastula or segmentation cavity);

(2) *Mesembryo* or blastophere; a multisegmented body with an internal cavity (blastula cavity);

(3) *Metembryo* or gastrula; a concavo-convex body consisting of two layers formed either by the invagination of the blastula or by the duplication of its cell-layers;

(4) *Neoembryo;* the condition of primary division into a cephalic, caudal, and subsequently a thoracic lobe, with posteriorly directed mantle and bundles of thoracic setæ.

FIG. 197.—*Terebratulina.* First ciliated stage. (MORSE.)

FIG. 198.—*Terebratulina.* Segmented embryos. (MORSE.)

(5) *Typembryo;* in which the mantle lobes have inverted and are folded over the cephalic lobe;

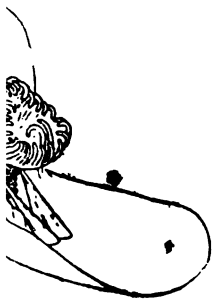
(6) *Phylembryo;* the state in which the characters of the brachiopod-type are defined.

When the egg becomes fertilized it may either remain attached to the mother and pass its early segmented stages in that condition, as in LACAZELLA, or it may be set free into the pallial chamber or into the sea-water. Some such ova develop cilia be-

FIG. 199.—*Terebratulina.* Embryos attached by the caudal segment and showing the gradual inclosure of the cephalic segment by the lobes of the mantle. (MORSE.)

fore segmentation (TEREBRATULINA) and are thus free swimmers; others evidently have no means of locomotion. Where the cilia

eveloped in the unsegmented condition they are retained g the blastula and gastrula stages. With the completion of the primary segmentation and the formation of the segmentation cavity or archenteron, follows the division of the embryo into a cephalic and caudal lobe, and the formation of two lateral diverticula from the segmentation cavity. This is the primary *cephalula* stage of the neoembryo, which becomes completed by the development of a third, a median or thoracic lobe, from which four bundles of long setæ are extended posteriorly beyond the caudal lobe (CISTELLA). The cephalic and caudal are cilated but the median lobe is not. At the time a single pair of pigment-dots or eyes devel- on the cephalic segment. In a later condition a d pair of eye spots appears, the thoracic or median becomes elongated and its outer layer *tle*) differentiated from the body of obe. During this stage the embryo become attached by its caudal segment dicle (TEREBRATULINA). The two divi- or lappets of the mantle, which in ast stage embraced the thoracic lobe ow inverted or revolved upon their of attachment, until they gradually se the cephalic lobe, and their margins, the bundles of setæ, are directed ante- instead of posteriorly. This initiates pembryo stage.



— *Terebratulina*; a very shell showing the ciliated r lophophore and the di- muscles. x 20 (MORSE).

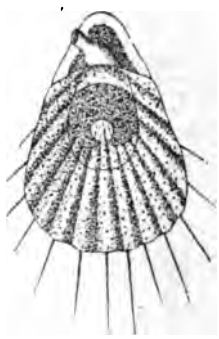


FIG. 201.— *Terebratulina*; a young shell having the punctæ developed. x 20 (MORSE).

this time CISTELLA becomes attached by its caudal segment gh the pedicle in GLOTTIDIA is not as yet developed.

e cephalic lobe now rapidly becomes diminished in size. digestive tube had already been formed by the tubular ding of the walls of this lobe. The muscles in CISTELLA ow in four pairs, two of which extend from the walls of igestive cavity to the bases of the marginal setæ; these ward become the *adductor* muscles of the adult animal.

One pair extends to the caudal lobe and becomes the ventral

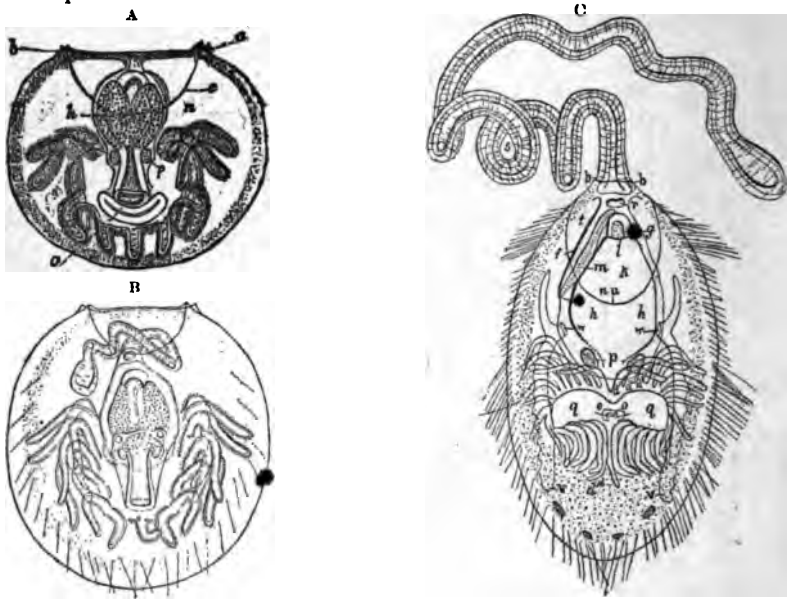


FIG. 202 — Embryonic stages of *Glottidia Audebarti*. A, Dorsal view of the youngest embryo observed; B, Dorsal view of a somewhat older embryo; C, Ventral view of an individual soon after becoming sedentary; *a*, hinge-teeth of brachial valve; *b*, hinge-teeth of pedicle-valve; *c*, semicircular plate of brachial valve; *d*, median tentacle; *f*, parietal bands; *g*, body cavity; *h*, liver; *k*, hepatic chamber of stomach; *l*, intestinal chamber of stomach; *m*, intestine; *n*, anus; *o*, mouth; *p*, muscles; *q*, lophophore; *r*, posterior unpaired muscle; *s*, pedicle; *v*, pallial sinus; *w*, its opening into the body cavity; *nu*, edge of larval shell. (BROOKS.)

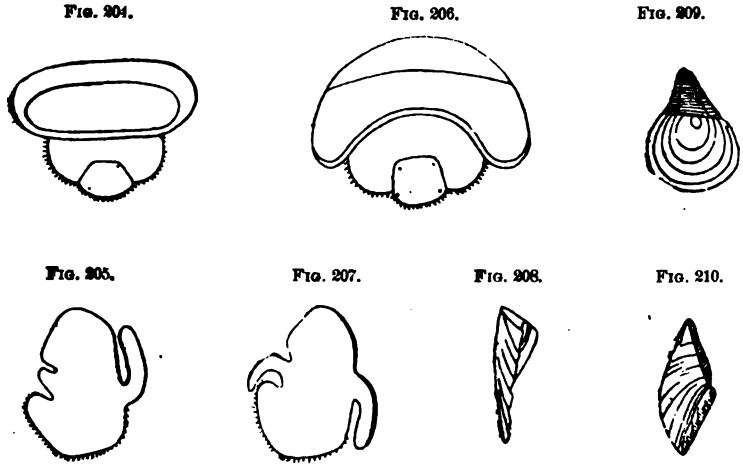
FIG. 203.— Diagrammatic longitudinal section of young of *Glottidia*. *p*, pedicle-valve; *b*, brachial valve; *a*, umbonal muscle; *c*, stomach; *d*, mouth; *e*, lophophore; *f*, ganglion; *g*, border of mantle.— (BROOKS.)

pedicle-muscles. The fourth pair extends from the dorsal to the ventral wall of the body, just behind the digestive cavity; this becomes the *diductor* muscles. There is a fifth pair of dorsal pedicle-muscles in LIOTHYRINA.

Following this condition the four bundles of setæ are lost, the eye spots disappear, the digestive tube and stomach become well defined, the cilia of the brachia or lophophore appear, and the valves of the shell, which before had been simple plates upon the surface of the mantle lobes, come into contact about their lateral and anterior margins. The animal has now taken on the appearance of a brachiopod and is a phylembryo. Later growth to the adult condition consists in the perfecting of the details now outlined in the embryo.

The Development of the Shell.

There are at least two types of shell development among the articulate brachiopods. One of these is exemplified by THECIDIUM, which has been shown by BEECHER to be a living representative of the extinct palæozoic group provided with a deltidium formed of a single plate or sheath; like STROPHOMENA and its allies. (Plate



Thecidium (Lacazella) mediterraneum.

FIG. 204.— Cephalula, dorsal side; showing below, the cephalic segment with eye-spots, and on the upper segment the dorsal shell-plate.

FIG. 205.— Dorso-ventral longitudinal section of cephalula; below is the cephalic segment, at the right the dorsal mantle lobe, the thickened line on its inner margin representing the beginning of the dorsal valve, and the similar line on the adjoining side of the body the incipient deltidium.

FIG. 206.—A later growth stage (typembryo), in which the mantle lobes have turned downward. The body shell plate is seen in theupper part of the figure.

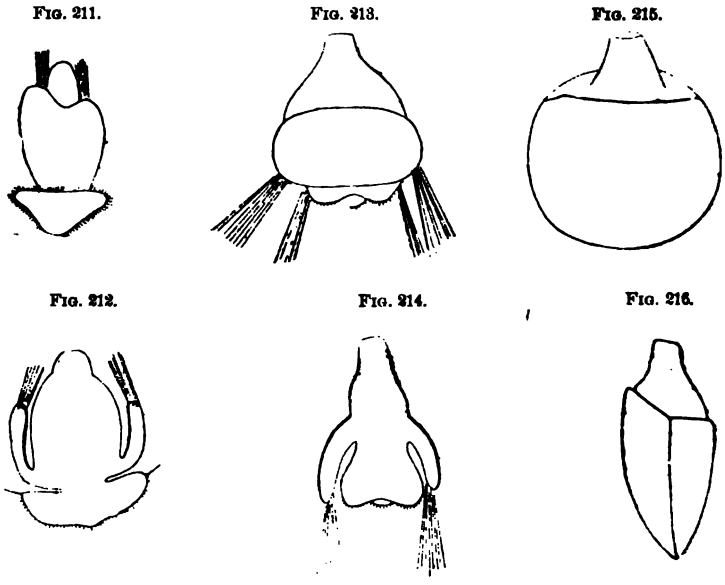
FIG. 207.— Dorso-ventral longitudinal section of the preceding; showing the inversion of both mantle lobes. The relations of the dorsal and body (deltidium) plates are shown by the heavy lines at the right. The ventral plate is also seen on the lobe at the left.

FIG. 208.— Profile of a very young specimen of *Leptæna rhomboidalis* oriented to correspond with the foregoing figures.

FIGS. 209, 210.— Views of adult *Thecidium (Lacazella) mediterraneum* similarly placed. (BEECHER; figs. 204-207, adapted from KOVALEVSKI.)

16, Figs. 1-18.) The other is represented by CISTELLA, which typifies the group bearing discrete deltidial plates. In both of these, the first traces of the shell are found in the neoembryo. In the cephalula stage of *Thecidium (Lacazella) mediterraneum* the dorsal lobe of the mantle develops more rapidly than the ventral, and its inner surface bears a flat shell-plate. A similar plate is

developed on the body of the thoracic lobe covered by this portion of the mantle. Subsequently, during the neoembryonic period, a shell-plate is also formed on the inner surface of the ventral lobe of the mantle. By the inversion of the mantle-lobes, these plates formed on their inner surfaces, become external and inclose the cephalic lobe. Their attached or inner edges,



Cistella neapolitana.

FIG. 211.—The completed cephalula stage; the ventral and dorsal mantle lobes are at the right and left respectively.

FIG. 212.—Longitudinal section of the same; the shell secreting surfaces are represented by heavy lines.

Fig. 213.—Typembryo; the larva after the inversion of the mantle lobes.

FIG. 214.—Longitudinal section based on the preceding. The shell bearing surface of the mantle lobes are now on the outside of the animal, the large pedicle extending downward.

FIGS. 215 and 216.—Dorsal and profile views of a very young shell; showing the large posterior opening between the valves and the thick pedicle. (BEECHER, adapted from KOVALEVSKI and SHIPLEY.)

though separated by the entire width of the thoracic segment, make the hinge-line. The body-plate is now in contact with the dorsal-plate or valve at its inner edge, but does not touch the ventral valve, the two latter being separated by the width of the caudal lobe or pedicle. This body-plate, or third valve, is the incipient *deltidium*. Subsequently, by lateral extension, the dorsal and ventral valves come into contact at their cardinal

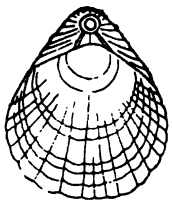
extremities; the ventral valve meets the deltidium and becomes anchylosed with it, leaving an opening for the passage of the pedicle. The union of the three shell-plates in the phylembryo forms the completed embryonic shell or *protegulum*.

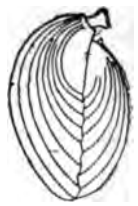
In CISTELLA, and presumably in all articulate brachiopods possessing deltidial plates, the mode of development of the shell

FIG. 217.—Dethyrium of a young *Rhynchonella* without deltidial plates.

FIG. 218.—The same at a later stage with two triangular deltidial plates.

FIG. 219.—The same at completed growth of the deltidial plates.





FIGS. 220 and 221.—Dorsal and profile views of *Magellania flavescens*, showing deltidial plates and pedicle.

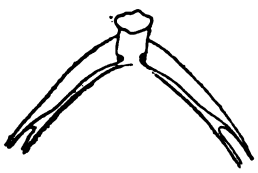


FIG. 222.—Dorsal view of the umbonal portion of an adult *Terebratulina septentrionalis* with the shell removed by acid: showing slight secondary extensions of the central mantle around the pedicle, small deltidial plates only, being secreted in this species.

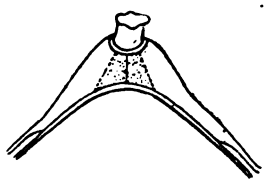


FIG. 223.—Similar preparation of *Magellania flavescens*; showing the complete envelopment of the base of the pedicle by secondary expansions of the ventral mantle which have formed the deltidial plates, as shown in fig. 220. (After BEECHER.)

is quite different. The ventral lobe of the mantle is here the longer, and no body-plate is formed on either side of the thoracic lobe. When, therefore, the mantle lobes are reversed and the valves come into contact about their peripheries and at the cardinal extremities, the caudal lobe, or pedicle, occupies all the space between the posterior margins of the valves. The large,

triangular, unclosed fissure thus formed, persists throughout early post-embryonic growth-stages. It has already been observed that the period at which deltidial plates begin to appear, and the degree of development which they attain in this group, varies with the species. Thus in most forms of RHYNCHOSPIRA and in *Meristina Maria* they are completed at an early adolescent stage, while in *Meristina rectirostra*, they are in a primary condition of development at maturity, and the pedicle is at no time restricted to a foramen.

In MAGELLANIA when the deltidial plates begin to develop, it has been found that they are secreted by secondary extensions of the ventral mantle from along the margins of the deltidium, these laminar processes beginning at the cardinal margin and meeting though not uniting along an axial line. (BEECHER.)

It is therefore to be concluded that the deltidial plates are of post-embryonic or secondary growth and that the absence of the body-plate or deltidium in the embryo of CISTELLA is to be regarded as an instance of acceleration of development in which this primary phase has been omitted.

There is a difference in the intimate structure of the deltidium and deltidial plates, in punctate shells; the former being developed from the body of the thoracic lobe and not from the mantle, and has no punctæ; the latter, originating from the mantle, are perforated by its cæcal extensions.

Orbiculoidea minuta.

Three growth stages; showing the change from the paterina-stage with transverse cardinal margin, to the circular outline of the adult. Fig. 224 x 36; fig. 225 x 16; fig. 226 x 10; figs. 224 and 225 show the form of the protoconch. (BEECHER.)

In many of the brachiopoda the *protegulum* or embryo shell is retained throughout later growth stages. This is true where the apices of the valves have not become greatly modified by the encroachment of the pedicle. Its valves are subsemicircular and smooth, the hinge-line straight and its general form exemplified in the adult condition of the primordial genus PATERINA.

POST-EMBRYONIC STAGES.

With the completion of the protegulum and the incipient development of the lophophore, the embryonic condition of brachiopod may be regarded as closed. The subsequent periods in the life of the animal may be divided into (*a*) the infantile; (*b*) the adolescent; (*c*) the adult; (*d*) the senile.

During the infantile condition, additions made to the protegulum usually modified the outline of the shell, and bear only the concentric lines upon the surface. The cæcal perforations of the shell appear at this period (TEREBRATULINA). The animal is usually attached by its pedicle, but in GLOTTIDIA this organ is not yet protruded from between the valves. In the adolescent period the shell takes on the normal outline of the species, and surface plications and other external ornament and configuration now make their appearance. The lobes of the lophophore become developed, the digestive tract extended and completed, and, in GLOTTIDIA, the pedicle is protruded and highly developed. After passing the period of maturity, the senile shell undergoes various changes. Callosities and deposits of adventitious calcareous matter are formed about the internal processes; the valves are thickened instead of being increased in diameter, the characteristic ornamentation of the shell may be temporarily or permanently lost, and the surface become smooth. Growth in this period of decline is reversional, manifesting a resumption of infantile characters. HYATT has defined two stages of senile growth; one preliminary or progressional, that in which the characters of maturity are disappearing in the reverse order of their appearance; the other, extreme or final, when the shell has finally reverted to its own condition during the infantile period.

FIG. 227.—*Terebratulina*. A very young shell, with pedicle, cilia, setæ and punctæ developed. (x 300) (MORSE).

A chapter on CLASSIFICATION will follow the discussions of the genera.

THE GENERA OF THE BRACHIOPODA.

I.

BRACHIOPODA INARTICULATA.

Valves inarticulated; intestine terminating in an anus on one side of the body; shell substance largely phosphatic.

The foregoing characters bring into association a well defined assemblage of these organisms, but, while generally applicable throughout the group in expressing the fundamental distinctions from the more abundantly developed BRACHIOPODA ARTICULATA, there often appear, in forms which can not be separated from such association, tendencies to transgress these limitations in various directions. For example, articulation of the valves was approached, if not effected, in the linguloid BARROISELLA, in SPONDYLOBOLUS, and, perhaps also, in NEOBOLUS and TRIMERELLA. In CRANIA, according to the determination of JOUBIN, the anus opens in the median line of the body; and in various genera, CRANIA, PHOLIDOPS, TRIMERELLA, etc., there is evidence that the substance of the shell was essentially, or altogether calcareous.

For this division of the Brachiopoda it seems preferable to adopt Professor HUXLEY's term, INARTICULATA, as having the advantage of euphony and simplicity. Other writers have made use of terms with different significations, all having precisely the same scope. Professor OWEN, in 1858, proposed the term LYOROMATA (λύω and σῶμα), essentially the Greek equivalent of INARTICULATA, and of BRONN's ECARDINES. The last named author also suggested the term PLEUROPYGIA, derived from the lateral position of the intestinal perforation; while KING's term, TRETENTERATA, indicates that the existence of an anus is to be regarded as the essential character.

Lingula, Bruguière. 1789.

(Plate 1, Figs. 1–9).

Shells sub-equivalve; elongate-ovate, sub-quadrate or sub-triangular in outline; broad over the pallial region, cardinal slopes more or less conspicuous; slightly gaping at both extremities. Brachial valve somewhat the shorter, and with a slightly thickened hinge-line. Surface of the shell smooth, or concentrically and radiately striated. Animal attached by a long, mus-

ular pedicle protruding from between the beaks of the two valves. The pedicle-valve has a distinct cardinal shelf or area, divided longitudinally by a depression widening from the apex anteriorly, and termed by KING the "deltidium." This, according to Professor KING, is usually not well developed, and in the average specimens of *L. anatina* found in museum collections, appears to be partially or quite wanting, from accidental causes. The deltidium is bounded at the sides by elevated ridges, which, at the anterior ends, are each developed into a small callosity.

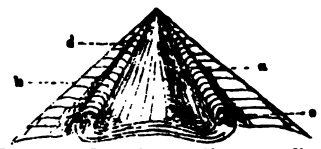


FIG. 228.— *Lingula anatina*; cardinal area of pedicle-valve, after KING. *a*, deltidium; *b*, deltidial ridges; *c*, deltidial callosities; *d*, areal borders.

Muscular impressions numerous, but usually indistinct. In the recent species they are twelve in number upon each valve, and are somewhat unsymmetrical in their arrangement. They may be designated as follows: The *umbonal* impressions (*g*), produced by a single muscular band passing directly across the cavity of the shell near the beaks, and by their contraction opening the valves; the *lateral* impressions, which are produced by three pairs of muscles, the *anteriors* (*j*) passing from near the lateral boundaries of the visceral area on the pedicle-valve, forward to the anterior extremity of this tract on the brachial valve; the *middles* (*k*) passing in just the opposite direction, from the anterior region of the pedicle-valve to the lateral region of the brachial valve; the *externals* (*l*) passing from the ante-lateral region of the pedicle-valve to the post-lateral region of the brachial valve, these muscles serving to move the valves forward and backward.

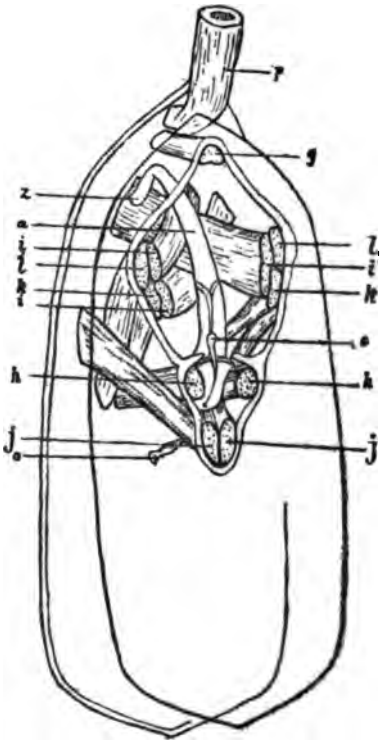


FIG. 229.— *Lingula anatina* after HANCOCK. *p*, pedicle; *g*, umbonal muscle; *h*, centrals; *i*, transmedians; *j*, *k*, *l*, laterals (*j*, anteriors, *k*, middles, *l*, externals); *e*, heart; *o*, mouth, *a*, alimentary canal; *z*, anus.

The *central* impressions (*h*) are

produced by a single pair of muscles extending across the antelateral region of the visceral area, and by the contraction of these, the valves are closed. The *transmedian* impressions (*i*), are made by a triple muscle, one band of which is on one side the visceral area, the other two on the other side, the two lateral components crossing each other in passing from the posterior region of the pedicle-valve to the medio-lateral region of the opposite valve. By the action of these muscles the animal is able to slide apart, laterally, the anterior and posterior extremities of its valves. The muscular region in each valve is surrounded by the *parietal* bands (*b*), which leave more or less distinct impressions upon the shell.

The anterior internal surface of each valve bears traces of two strong pallial sinuses, which nearly meet in the axial line before reaching the anterior margin. In front of, and behind these are to be seen radiating vascular markings.

Shell substance composed of alternating lamellæ of chitinous and calcareous material.

Type, *Lingula anatina*, Lamarck.

Distribution. (Cambrian?) Lower Silurian — Recent (China, Japan, Guinea, Australia, Philippines, Sandwich Islands.) The genus attained its culmination in the Silurian and Devonian, about seventy species being known from the former on the North American continent.

Remarks. There are at present no satisfactory means of separating generically, from the type of the genus, the great majority of fossils passing under the name of LINGULA. Internal casts bearing muscular and pallial impressions quite similar to those of recent species have been found in rocks as old as the Lower Silurian (Trenton), and whenever traces of such internal markings are preserved, there seems to be little difficulty in reconciling them with those of the living shells. Favorably preserved examples from the Carboniferous have shown even the unsymmetrical scars of the lateral or sliding muscles. In many of the extinct forms it is evident that the scars were deeper and the shells thicker and more calcareous than in the species now extant.

The retention of the pedicle in the fossil state has been observed in some Silurian and Carboniferous species.

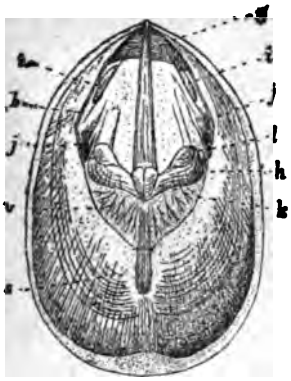


FIG. 230.—*Lingula paracletus*, HALL. Interior of pedicle-valve.

FIG 231.—*Lingula ? Lesueri*, Ronault; with pedicle. (DAVIDSON.)

Subgenus **Glottidia**, Dall. 1870.

Animal free, and forming a tube or capsule about the pedicle by the agglutination of sand grains, etc.; pedicle highly contractile. Interior of pedicle-valve with two septal ridges diverging from the beak; brachial valve with a single median ridge.

Type, *G. albida*, Hinds (sp.)

Glottidia Palmeri.

FIG, 232.—Interior of pedicle-valve.
FIG. 233.—Interior of brachial valve. (DAVIDSON.)

Distribution. (Fossil?) Recent (California, the Carolinas). This subgenus is regarded by Dall as the representative of LINGULA in American seas.

Subgenus **Dignomia**, Hall. 1871.

(Plate 1, figs. 12, 13.)

Shells with broad, flat median ridge and lateral, sub-marginal parietal grooves in the pedicle-valve, a more conspicuous median ridge in the brachial valve, with submarginal, diverging ridges corresponding to the grooves of the opposite valve.

Type, *Dignomia alveata*, Hall. Hamilton group (Devonian).

Subgenus **Glossina**, Phillips. 1848.

(Plate 1, figs. 10, 11.)

Outlines subtrigonal; beaks acuminate. Internal markings obscure.

Type, *Glossina attenuata*, Sowerby (Sp.).

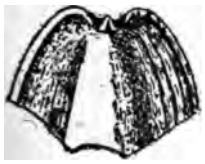
Distribution. Lower Silurian—Devonian (?).

Barroisella, Hall. 1892.

(Plate 1, figs. 14, 15.)

Shell externally as in LINGULA. The pedicle-valve bears a high cardinal area, which is a thickened triangular plate divided by a broad pedicle-groove. On the basal margin of the cardinal area, at the angles made by the lateral margins of the pedicle-groove, is a pair of bosses or condyles, which have served either as muscular fulcra, or, to some extent, as points of articulation with the opposite valve. The interior of the pedicle-valve bears a subquadrate depressed area lying directly beneath, and almost in continuation of the pedicle-groove; this may represent the umbonal muscular scar. From its ante-lateral angles diverge two sharply defined, linear depressions, which extend about one-fourth the length of the shell, and end abruptly. From outside and behind the extremities of these depressions, begins a pair of long, curved furrows, composed of two shorter curves, the posterior rounding over the extremities of the linear depressions referred to, the anterior and longer curves gradually approximating and nearly meeting at a point about one-third the shell's length from the anterior margin. These furrows are accompanied by low ridges along their inner margin. A low median ridge, with elevated edges, begins at the posterior umbonal impression, and continues to the center of the valve, widening near its anterior extremity. Just behind its termination is a pair of small, usually indistinct muscular impressions, probably the scars of the central muscles.

In the brachial valve the beak is scarcely prominent, and the muscular markings are essentially as in the opposite valve, but more sharply developed. Beneath the beak is a faint umbonal scar, the lines diverging from which are discernible. The long compound lateral curves have a considerably greater degree of curvature than in the pedicle-valve, their posterior portion inclosing a thickened area, which is continued into a peculiar low and thickened median septum, bifurcating in the middle of the valve, the angle being occupied by an intercalated ridge, which extends for twice the length of the branches of the septum. The central



FIGS. 234, 235.—*Lingula Criei.* Internal cast and interior of posterior portion of pedicle-valve. (DAVIDSON.)

FIG. 236.—*Lingula Criei.* Internal cast of pedicle-valve. Natural size. (DAVIDSON.)

scars are situated further backward at the junction of the median septum with the posterior thickened area.

Type, *Barroisella subspatulata*, Meek and Worthen (sp.). Genesee slate (Devonian).

Distribution. Silurian—Devonian.

Subgenus **Tomasina**, Hall. 1892.

Externally like LINGULA. The pedicle-valve is very slightly convex, its posterior margin being notched. This notch is divided medially by a small triangular elevation at the base of which, on the inner margin of the valve, are two conspicuous articulating (?) processes.

Type, *Tomasina Criei*, Davidson (sp.). Silurian.

Lingulepis, Hall. 1863.

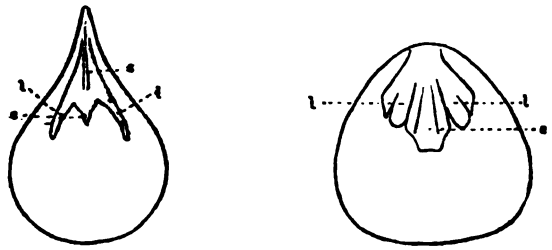
(Plate 1, figs. 16, 17.)

Shells linguloid; pedicle-valve attenuate and produced at the beak; brachial valve obtusely ovate.

On the interior the pedicle-valve bears a single large scar, occupying the entire umbonal region, which is produced anteriorly

into two narrow lateral branches, extending for about one-half the length of the shell. Between them and continuous with their posterior portion, lies a central scar, not extending so far forward, but together with the lateral branches giving the entire muscular impression a strongly tripartite character. There is a low median ridge, elevated along its margins, depressed in the middle; similar to but fainter than in *Lingula unatina*.

In the brachial valve the muscular impressions make a conspicuous flabelliform scar, extending medially about one-half the length of the shell. The central portion of this scar is accompanied on either side by broader, partially resolvable lateral



FIGS. 237, 238.—*Lingulepis pinniformis*. *l*, lateral scars; *c*, central scars; *s*, septum.

scars, all the subdivisions of the impression coalescing in the unbonal region. There is no septum in this valve.

Type, *Lingulepis pinniformis*, Owen (sp.).

Distribution. Cambrian. About six species are known in American faunas.

Lingulella, Salter. 1866.

(Plate 3. Figs. 1–4.)

Shells linguloid externally. The passage for the pedicle is a sharply defined slit, not merely making a depression upon the surface of the cardinal area but apparently penetrating it from apex to cardinal line. In the interior the pedicle-valve bears two long, narrow crescentic lateral scars, and shorter, more or less coalesced central scars, somewhat tripartite in outline.

FIG. 239.—Cardinal area of *Lingulella Davisi*. (DAVIDSON.)

In the brachial valve are two diverging lateral scars, extending about one-half the length of the shell, and incurving at their

anterior ends toward the more conspicuous, and apparently compound central scar.

Type, *Lingulella Davisi*, McCoy (sp.).

Lingulella Ella, Hall and Whitfield. FIG. 240.—Dorsal aspect, showing pedicle-area. FIG. 241.—Internal cast of pedicle-valve. FIG. 242.—Internal cast of brachial valve. (WALCOTT.)

Distribution. Cambrian — (?) Lower Silurian.

It is possible that the Devonian (Hamilton) species *Lingula paliformis*, Hall, belongs to this genus.

Lingulops, Hall. 1871.

(Plate 1, Figs. 18–20.)

Shells small, linguloid; both valves with a relatively broad cardinal area, which is divided transversely into two parts, (*a*) a smooth, narrow, apical portion; (*b*) a broad inner band, along which the valves appear to have been in contact. This band is flattened and projects into the interior cavity of the shell, like a narrow lunate shelf; on the pedicle-valve it is concentrically striated or smooth, and gently convex. The pedicle-groove crosses this inner area only, not encroaching on the apical area of either valve. Directly in front of the cardinal area, is a narrow crescentic ridge, the anterior margin of which is deeply excavated. This ridge, which is parallel and co-extensive with the cardinal area, bears a median angulation, projecting backward toward the pedicle-groove.

In the interior of the pedicle-valve is an elongate median muscular scar accompanied by two pairs of lateral scars. The median portion of the muscular area is thickened, forming an incipient platform, from the anterior edge of which extends a median septum. The posterior margin of the muscular area bears a trilobed parietal scar.

The interior of the brachial valve shows the cardinal area, pedicle-groove and the crescentic ridges essentially as on the

opposite valve. The muscular scallops are represented by three depressions, closer together than in the other valve. The platform is here more highly developed and shows on its surface indications of the median and lateral muscular scars. No median septum is present in this valve.

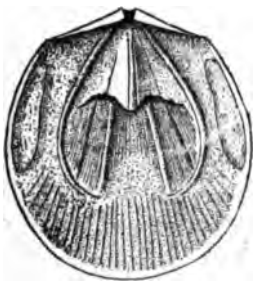
Type, *Lingulops Whitfieldi*, Hall.

Distribution. Silurian (Hudson River — Niagara groups). Four species are known in North and South American faunas.

Lakhmina, Œhlert. 1887.

Synonym; *Davidsonella*, Waagen.

General outline more or less linguloid. The pedicle-valve is the larger and possesses a prominent apex, which is provided, on its lower surface, with a deep furrow for the pedicle. In the inte-



Lakhmina linguloides, after WAAGEN.

FIG. 243.— Pedicle-valve. FIG. 244.— Brachial valve.

rior of the pedicle-valve, the cardinal margin is somewhat thickened, without forming a distinct area. Below this is a not very large triangular vaulted platform, supported by a median partition not extending beyond its anterior margin. This platform is inclosed by low, rounded ridges which originate near the pedicle-furrow; its surface is flattened medially, but concave on the sides. Of muscular impressions nothing has been observed. In the dorsal valve the cardinal margin is but little thickened and slightly curved. In the middle it bears a thickened process, which is directed somewhat upward and inward, extending partly into the apical cavity of the other valve. From beneath this process, a short thickened platform takes its origin; it is not even on the upper surface, but to all appearances spirally

rolled; it is concave in the middle and bears on both sides elevated crests with sloping lateral faces; its anterior margin is curved inward, and the whole platform seems to be excavated below. From its sides diverge two bifurcating ridges, and a median septum extends nearly to the anterior margin. Near the lateral margins two sharply defined spaces are inclosed by narrow ridges. The interiors of both valves are marked with radiating striæ. Shells small; shell substance very thin.

Type, *Lakhmina linguloides*, Waagen (sp.). Obolus-beds of India (Cambrian). But one species is known.

Lingulasma, Ulrich. 1889.

(Plate 1, Figs. 21–24.)

Shells large, sub-quadrate, linguliform, sub-equivalve; the brachial valve considerably the deeper. Beaks apical, cardinal margins gently sloping to the sides. External surface covered with concentric or radiating lines and bead-like granules. Shell substance thick, largely calcareous.

Interior of the pedicle-valve with a low, concave platform which extends over one-half the length of the shell, and is not hollowed on its anterior wall. The pedicle-area has been largely inclosed within the shell, making a distinct sheath or shelf, beneath which lie the apical portions of the central and lateral muscular scars. Crescentic scars scarcely defined.

The brachial valve is deep, with a high platform of about the same extent as that on the other valve, sloping inward near its anterior margin and continued axially into a strong septum which reaches nearly to the front of the valve. The anterior walls of the platform are broadly excavated, and close against the base of the septum are hollowed out into short conical cavities. The crescent is strongly developed, sharply pointed backward at its center. Its lateral curves are broad, reaching to the edge of the platform. Directly in front of its central angle lies a short, sharp, median ridge, which disappears near the center of the platform. Lateral and central muscular scars well developed.

Type, *Lingulasma Schucherti*, Ulrich. Hudson River group (Lower Silurian).

Trimerella, Billings. 1862.

(Plate 2, Figs. 9–12.)

Synonym; *Gotlandia*, Dall. 1870.

Shells thick; outline ovate.

Pedicle-valve with an erect and straight umbo, which is usually solid for the greater part of its length, but double-chambered toward its base; cardinal area very prominent; deltidium broad;

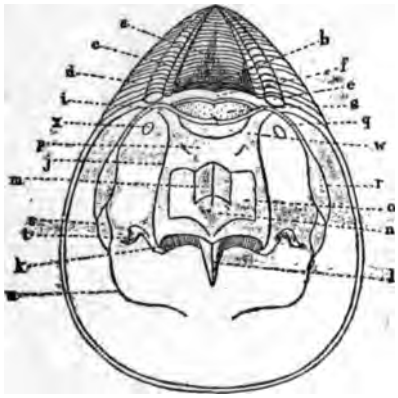


FIG. 245.—Pedicle valve of *Trimerella*.

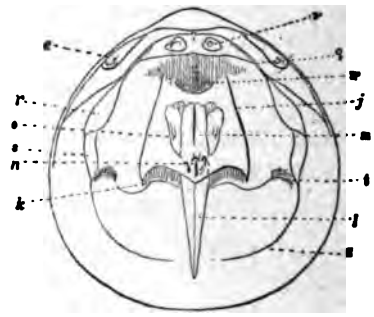


FIG. 246.—Brachial valve of *Trimerella*.

After DAVIDSON and KING.

a, deltidium.
b, deltidial slope.
c, deltidial ridges.
d, areal borders.
e, cardinal callosities.
f, cardinal facet.
g, lozenge.
h, cardinal buttress.
i, umbonal chambers.
j, platform.
k, platform vaults.
l, median plate.
m, median scars.
n, anterior scars.
o, lateral scars.
p, post-median scars.
q, crown } crescent.
r, side }
s, end }
t, transverse scars.
u, archlet (vascular sinuses).
w, sub-cardinal scars.
x, umbo-lateral scars.

e, cardinal sockets.
j, platform.
k, platform vaults.
l, median plate.
m, median scars.
n, anterior scars.
o, lateral scars
p, post-median scars.
q, crown } crescent.
r, side }
s, end }
t, transverse scars.
u, archlet (vascular sinuses).
v, cardinal scars.
w, sub-cardinal scars.

deltidial ridges more or less conspicuous; deltidial callosities slightly developed; cardinal slope well-defined. Crescent sharply incised over its summit, but faint toward the sides, where it is connected with the broad lateral and terminal scars, which are not so distinctly outlined as in the allied genera. Platform long, narrow and strongly developed; platform vaults tubular, the

dividing wall being continued as a short septum in front of the platform. Muscular scars of the platform usually extremely faint, but under favorable preservation divisible into median and lateral components. Pallial sinuses faint.

Brachial valve with a marginal beak, which is much thickened in some instances, without producing a cardinal area, though making a prominent apophysis which is extended against the cardinal slope of the opposite valve. Crescent as in the other valve. Platform higher than in the pedicle-valve, its vaults extending scarcely so far backward. Anterior median septum long, often reaching almost to the margin. Muscular and pallial impressions faint.

Type, *Trimerella grandis*, Billings.

Distribution. Upper Silurian. (Illinois, Wisconsin, Ohio, Province of Ontario, Gotland, Farö.) Five species are known in American faunas and two additional species occur in the Swedish rocks.

Dinobolus, Hall. 1871.

(Plate 2, Figs. 1–4.)

Synonyms; *Conradia*, Hall, 1862; *Obobellina*, Billings, 1871.

Shell sub-circular; valves convex, thick.

Pedicle-valve with an acute and slender beak; cardinal area triangular, more or less elevated, but never so high as in TRIMERELLA or MONOMERELLA. Cardinal margins sometimes of considerable width. Umbo generally solid, but often slightly excavated on either side of a simple or double vertical wall, or buttress. Crescent distinct, its apex making a retral angle; narrow over the crown, widening into the great terminal scars. Platform low, broadly V-shaped on its anterior margin, which usually lies at about the middle of the valve; generally, with very short, flattened, abruptly conical vaults, but occasionally these vaults are of the same relative length as in TRIMERELLA, though much shallower. Central and lateral muscular scars on the platform usually distinct, the former lying in a depressed median groove, the latter occupying the greater portion of the surface. Subcardinal and anterior scars rarely discernible. Anterior median septum scarcely developed. Pallial sinuses faint.

Brachial valve with the beak submarginal, inconspicuous, usually not discernible; hinge-area very narrow. Crescent very strong,

especially over the crown, where it makes a sharp posterior angle beneath the beak, sloping thence very gently, being almost transverse for about the width of the platform, then bending quite abruptly and being slightly interrupted at the position of the terminal scars, which are more approximate than in the opposite valve. In the type-species, the crown of the crescent, as usually developed, is a sharply incised, narrow furrow, bounded within by a broad elevation sloping to the position of the subcardinal scar, but not infrequently it is a ridge, bounded in front and behind by a deep furrow. This difference in appearance is due to the varying development of the anterior furrow, which is sometimes quite suppressed. Platform narrower and more sharply V-shaped than in the opposite valve; vaultsusually very short and abruptly conical. Lateral and central scars on the platform conspicuous, the latter lying in a deep median furrow, at the front end of which are sometimes seen the faint anterior scars. In the line of this furrow, directly in front of the apex of the crescent, lies the deep impression of the subcardinal muscle, which make a prominent feature on the cast, suggestive of the filling of the umbonal cavity, which it may be to some extent, although the apex of the beak is actually quite remote from it. From this point to the center of the crescent extends a short furrow, on either side of which lies the impression of an accessory scar, probably correlative with the umbo-lateral scars of RHINOBOLUS and TRIMERELLA. Pallial sinuses more or less distinct. Median septum low, but stronger than in the opposite valve. External surface smooth, or with concentric, sublamellose growth-lines.

Type, *Dinobolus Conradi*, Hall.

Distribution. Lower and Upper Silurian. Nine species have been recorded, one from the Lower Silurian of Brittany, another from Esthonia, three from the same division in North America, one in the Upper Silurian of North America, Gotland and Bohemia, and three from the same division in Great Britain.

Monomerella, Billings. 1871.

(Plate 2, Figs. 5, 6.)

Shell usually thick; outline varying from elongate-ovate to subcircular. Surfaces of contact of the valves sometimes conspicuously broad.

Pedicle-valve with a more or less elevated umbo, which may vary in height in a given species; umbonal cavity divided into two chambers by a longitudinal septum. Cardinal area large; deltidial ridges and deltidial callosities not always distinctly developed; cardinal slope usually well defined, merging anteriorly into the cardinal buttress, or umbonal septum; in some species this slope, or subtriangular area, is longitudinally divided by a furrow. The crescent is sharply impressed over the cardinal slope; terminal scars broad and distinct. Platform more or less developed; divided by the cardinal buttress, which extends nearly or quite its entire length. Muscular impression on the platform very large, covering the entire surface, but scarcely resolvable into separate scars. Anterior septum faint, usually imperceptible. Pallial sinuses sometimes clearly defined.

Brachial valve with the umbo seldom conspicuously developed, the umbonal cavity being usually simple and deep, but sometimes filled by a deposition of shelly matter. Crescent sharply impressed over the narrow cardinal slope, and produced into broad, indistinct, composite, terminal scars. Platform usually well developed and broadly excavate on its anterior walls, but sometimes scarcely discernible. Anterior and lateral scars sharply defined, giving a tripartite appearance to the platform. Anterior septum more strongly developed than in the opposite valve.

Type, *Monomerella prisca*, Billings.

Distribution, Upper Silurian. Eight species are known, six of which occur in the Niagara and Guelph faunas of North America, two on the island of Gotland and one in Livonia.

Rhinobolus, Hall. 1871.

(Plate 2, Figs. 7, 8.)

Synonym; *Obolellina* (*partim*), Billings. 1871.

General form of the shell as in TRIMERELLA. Pedicle-valve, in the typical species, with an elevated, solid beak, having a broad and high deltidium, divided into a relatively narrow central area (which may be concave or convex), and broad deltidial ridges. Crescent and terminal scars as in TRIMERELLA. Umbo-lateral scars sharply defined. Platform very low and incompletely developed, consisting of a broadly V-shaped elevation, with a raised anterior margin, and surface sloping abruptly backward

to, or even below the general curvature of the internal surface. A faint longitudinal septum extends forward from the platform.

Brachial valve with low, sub-marginal, slightly-curved apex, and short deltidium. Crescent conspicuously developed. Platform as in the opposite valve, with the addition of a central scar, which gives the entire area a tripartite appearance. Median septum faint.

Type, *Rhinobolus Galtensis*, Billings (sp.).

Distribution. Upper Silurian; Niagara and Guelph faunas of North America; two species.

Obolella, Billings. 1861.

(Plate 3, Figs. 5–7.)

Synonym; *Dicellomus*, Hall. 1871.

Shell inarticulated, ovate or suborbicular, lenticular, smooth, concentrically or radiately striated, sometimes reticulated by both radiate and concentric striæ. Ventral valve with solid beak and a small, more or less distinctly grooved area. In the interior of the ventral valve there are two elongated, sublinear or petaloid muscular or vascular impressions, which extend forward from near the cardinal scars, sometimes to points in front of the mid-length of the shell. These are either straight or curved, parallel with each other, or diverging toward the front. Between these, at about the middle of the shell, is a pair of small impressions, and close to the hinge-line a third pair, likewise small, and often indistinct. There is also, at least in some species, a small pit near the hinge-line, in which the groove of the area seems to terminate.

The dorsal valve has a small, nearly flat hinge-facet; the minute beak is slightly incurved over the edge of the area. Beneath the beak there is a small subangular ridge, on each side of which there is a cardinal (?) scar. The elongate scars, which seem to correspond to the lateral impressions in the ventral valve, are here altogether in the upper half of the shell, diverging widely in their extension forward, and are generally very slightly impressed. In the cavity of the valve there is a low, rounded median ridge, which extends from a point near the hinge-line forward to a little below the mid-length of the valve. About the middle of the shell there are two small scars. These are usually

striated longitudinally, the median ridge passing between them. The area is coarsely striated.

Type, *Obolella chromatica*, Billings.

Distribution. Cambrian —— (?) Lower Silurian. The description by MICKWITZ of the interior of a species from the Ungulitensandstein, considered by him an OBOLUS (*O. Quenstedti*, Mickw.), renders the generic distinction between OBOLUS and OBOLELLA, for the time being, somewhat obscure. *Obolus Quenstedti* seems to possess the characters of OBOLELLA rather than of OBOLUS. The determination must rest upon future studies of *Obolus Apollinis*, Eichwald.

Elkania, Ford. 1886.

(Plate 3, Figs. 13, 14.)

Synonym; *Billingsia*, Ford. 1886.

Shells ovate or circular, biconvex; shell substance largely corneous and distinctly laminated. Apex of pedicle-valve marginal; within it is a broad subtriangular depression which merges into a deep central spoon-shaped cavity. Two narrow furrows diverge from its anterior extremity, separating the broad lateral muscular scars. Two small submarginal grooves pass from the beak outward, skirting the posterior portion of the lateral impressions, and appear to terminate in distinct subcircular scars situated near the lateral margins of the valve.

In the brachial valve is a thickened area in the umbonal region, presenting the appearance of a false cardinal area within the cavity of the umbo. This area is tripartite, bearing a deep, narrow central, and two broader lateral grooves; about its anterior margin lie two broad scars of the same character as the laterals of the other valve. There are also diverging furrows, which, starting at the marginal apex, pass over the edge of the thickened area, and are most deeply impressed at their anterior extremities.

Type, *Elkania desiderata*, Billings (sp.). (Cambrian; one species.)

Leptobolus, Hall. 1871.

(Plate 3, Figs. 8–12.)

Shells small, fragile, subovate in outline; shell substance semiphosphatic. Exterior with concentric growth-lines. The interior of the pedicle-valve shows a notably large cardinal area, which is sharply grooved. Beneath this area, in the bottom of the valve, is a broad depression extending nearly across the shell, and

Eichwald, was taken by VOLBORTH as the type of ACRITIS. The latter species is imperfectly known. MICKWITZ regards both AULONOTRETA and ACRITIS as synomyms of OBOLUS).

Pedicle-valve with a broad, subquadrate muscular scar crossed on its posterior portion by a transverse band connecting what appear to be cardinal scars.

Aulonotreta antiquissima. After VOLBORTH.

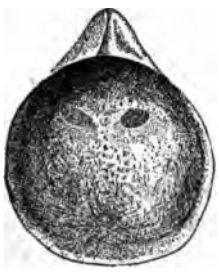
FIG. 246.—Interior of pedicle-valve. FIG. 247.—Interior of brachial valve.

In the brachial valve are two subcircular scars in the median region just within the posterior margin.

Type, *Aulonotreta antiquissima*, Eichwald. Cambrian.

Schmidtia, Volborth. 1869.

Pedicle-valve with a broad, centrally-grooved cardinal area, and, in the middle of the valve, two obliquely oval muscular impressions separated by an elevated ridge. In the brachial



Schmidtia celata. (VOLBORTH.)

FIG. 248.—Interior of pedicle-valve. FIG. 249.—Interior of brachial valve.

valve is also a low median ridge and a single pair of oval impressions.

Type, *Schmidtia celata.* Cambrian (Unguliten-schichten).

MICKWITZ considers this a synonym for OBOLUS.

Monobolina, Salter. 1865.

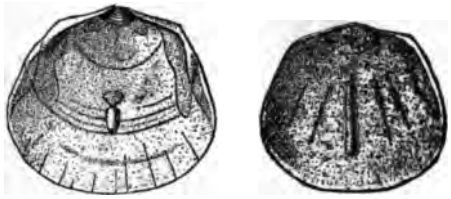
(Plate 4, Figs. 14, 15.)

Large oboloid shells with muscular scars concentrated along the median line.

Type, *M. plumbea*, Salter. Lower Silurian (Llandeilo).

Neobolus, Waagen. 1885.

Shell oboloid, with a somewhat transverse, slightly thickened posterior margin, which, in the pedicle-valve, is traversed by a broad, cross-striated pedicle-groove. The cardinal muscular scars lie close upon this groove; the central scars are faint, and in the figure, indistinctly defined, but are seen to abut against a short thickened ridge or knob in the middle of the shell. Marginal scars on both valves broad. In the brachial valve a strong longitudinally grooved callosity lies just within the cardinal margin, and this is more or less distinctly continued into a median septum. The arrangement of the muscular scars other than those referred to, is not fully understood.



Neobolus Warthi. After WAAGEN.
FIG. 250.— Interior of pedicle valve.
FIG. 251 — Interior of brachial valve.

Type, *Neobolus Warthi*, Waagen. Cambrian (India).

Spondylobolus, McCoy. 1852.

Shells subcircular, slightly narrowed towards the indistinct, short hinge-line; nearly equivalve, flattened. Small valve, with a slightly excentric apex; beneath which, on the interior, the substance of the valve is thickened into a wide, undefined boss. Opposite valve slightly longer, from the apex being perfectly marginal and slightly produced; channeled by a narrow, triangular groove below, the anterior end of which is flanked by two very prominent thick, conical, shelly bosses, representing hinge-teeth; substance of the valve thick, testaceous, not glossy, minutely fibrous, but not distinctly punc-

FIG. 252 — *Spondylobolus craniolaris*. After McCOY.

tated under a lens of moderate power, except by the ends of these fibers.

Type, *Spondylobolus craniolaris*, McCoy. Lower Silurian (Llandeilo).

Mickwitzia, Schmidt. 1888.

Shells large, thick, inequivalve. Brachial valve flat, circular; pedicle-valve oval, convex, produced into an acute apex, beneath which lies a triangular, more or less distinctly developed cardinal area. Valves not (?) articulated. Shell-substance composed of

Mickwitzia monilifera. (After SCHMIDT)

FIG. 253.—Pedicle-valve. FIG. 254.—Interior of same valve. FIG. 255.—Exterior of brachial valve.

thin, coarsely punctate layers alternating with prismatic laminæ which are traversed by scattered vertical canals. Surface covered with radiating striæ. Shell composed of calcic phosphate.

Type, *M. monilifera*, Linnarsson. Lower Cambrian.

Schizobolus, Ulrich. 1886.

(Plate 3, Figs. 16–19.)

Shell oval, slightly inequivalved; cardinal margins somewhat thickened. Shell substance largely corneous; external surface concentrically lined. In the pedicle-valve, the passage is very short, usually no more than a notch on the margin. From its inner end a median ridge extends one-third the distance across the valve, and this is flanked on each side by a low muscular callosity. Narrow curved lateral scars extend from the post-lateral margins of this callosity, continuing to, or beyond the center of the valve. In the brachial valve is a narrow thickened band directly within, and parallel to the posterior margin. Muscular thickening as in the opposite valve. No curved lateral scars.

Type, *Schizobolus truncatus*, Hall (sp.). Devonian.

A single species has been described; from the Genesee shales.

Discinolepis, Waagen. 1885.

Shell of very small size with two unequal valves, which are very flat, leaving scarcely any room for the animal between them.

The pedicle-valve depressed convex, the apex only being a little elevated and removed from the margin towards the median part of the valve. The posterior margin of the valve near the apex is broadly notched by a deep incision reaching to the beak.

Discinolepis granulata.
After WAAGEN.
FIG. 256.—Pedicle-valve. FIG. 257—Brachial-valve.

The brachial valve is similar in shape to the other, with a slightly elevated eccentric apex, but without an incision.

The surface in both valves is either smooth or finely granulose.

Type, *Discinolepis granulata*, Waagen. Cambrian (India).

Paterina, Beecher. 1891.

Valves semi-elliptical in outline, subequal, the pedicle-valve being slightly the more elevated. Hinge line equal to the greatest width of the shell, without cardinal area. Pedicle passage not limited except by the posterior margins of the valves.

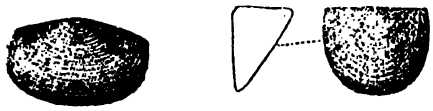


FIG. 258.— *Paterina Labradorica.* (WALCOTT.)

External surface covered with concentric lines terminating abruptly on the cardinal margin. Shell substance corneous.

Type, *Paterina Labradorica*, Billings (sp.). Cambrian. Only a single species of the genus is known.

Kutorgina, Billings. 1861.

(Plate 4, Figs. 11–13.)

Shells inequivalve, transverse or elongated. Hinge-line nearly equaling the greatest width of the shell. Pedicle-valve convex, greatly elevated at the beak, which is more or less incurved. Cardinal area very narrow, and divided by a wide pedicle-fissure. Brachial valve flat or slightly convex, beak marginal. Cardinal area very feebly developed. The posterior portion of the valves

is therefore unclosed for nearly the entire length of the hinge-line.

External surface covered with concentric lines, which terminate abruptly at the cardinal line.

Shell substance calcareous.

Type, *Kutorgina cingulata*, Billings. (Cambrian.)

A number of species from North America, Sweden and Great Britain have been referred to this genus, but it is doubtful if they are all congeneric. Some of them probably belong to PATERINA, Beecher, and others to SCHIZOPHOLIS, Waagen.

Schizopholis, Waagen. 1885.

Shells of very small size. Pedicle-valve slightly elevated, with a somewhat prominent marginal apex, below which is a small triangular area, crossed in the middle by a triangular fissure, a little widened at the top, forming a kind of foramen, placed

Schizopholis rugosa. Pedicle-valve. After WAAGEN.
FIG. 259.— Upper view.
FIG. 260.— Cardinal view.

just at the extremity of the apex. Brachial valve flat; imperforate.

Shell surface finely granular.

Of the internal characters of the genus nothing is known.

Type, *Schizopholis rugosa*, Waagen.

Distribution. Cambrian (India; North America, *S. Latourensis*, Matthew (sp.); *S. pannula*, White (sp.).

Volborthia, von Möller. 1873.

Shell convex, very inequivalve; contour as in KUTORGINA. Pedicle-valve elevated, incurved at the apex, and with a broad, sharply defined cardinal area, divided by a low convex ridge passing from the beak to the cardinal margin. There is no foramen.

Volborthia recurva. After VON MÖLLER.
FIG. 261.—Profile. FIG. 262.—Cardinal view.

Brachial valve convex; beak marginal; cardinal area not developed. Muscular impressions not known. Surface covered with concentric lines. Shell substance calcareo-corneous.

Type, *Volborthia recurva*, Kutorga (sp.). Lower Silurian.

Iphidea, Billings. 1872.

(Plate 4, Figs. 4, 5.)

Pedical-valve subconical; beak apical. Hinge-line short, nearly straight. Cardinal slope flattened, forming an imperfectly defined area, which is divided medially by a convex ridge or pedicle-covering. Foramen circular, apical.

Brachial valve moderately convex; most elevated at the beak. Internal characters not known. External surface covered with concentric striæ, which are continued over the area of the pedicle-valve. Shell substance corneous.

Type, *Iphidea bella*, Billings.

Distribution. Cambrian (Newfoundland, Vermont, Arizona, Sweden).

Acrothele, Linnarsson. 1876.

(Plate 8, Figs. 24–27.)

Shell corneous, composed of several laminæ. Pedicle-valve slightly conical, with excentric umbone, pierced by a minute foramen, in front of which there are two small wart-like protuberances; the area between the umbone and the posterior margin is usually a little flattened. Brachial valve with marginal umbone; in the interior of which there are two oblong, diverging muscular scars, close to the posterior margin, and two small rounded scars near the middle. The muscular scars are separated by a longitudinal ridge.

Type, *Acrothele coriacea*, Linnarsson.

Distribution. Cambrian — Lower Silurian (New Brunswick, Utah, Ireland, Bohemia, Sweden).

Acrotreta, Kutorga. 1888.

(Plate 3, Figs 28–30.)

Pedicle-valve subconical, the posterior slope being flattened, having a triangular form and resembling a cardinal area. This slope is divided medially by a groove, widening downward; at the apex of the valve is a circular foramen. On the interior this foramen penetrates a mammiform callosity.

Brachial valve flat or depressed convex; apex marginal; on the interior is a stout median ridge flanked by a large anterior and a smaller posterior pair of muscular impressions.

Exterior concentrically striated. Shell substance corneous.

Type, *Acrotreta subconica*, Kutorga.

Distribution, Cambrian — (?) Lower Silurian.

Conotreta, Walcott. 1888.

(Plate 4, figs. 1–3.)

Synonym: *Gelnitzia*, Hall. 1889.

Pedicle-valve conical, its height being greater than its length; apex with evidence of the external opening of the sipho. From the apex, a shallow furrow extends to the posterior margin, increasing in width downward. In young shells the posterior wall of the shell conforms to the curvature of the rest of the surface, interrupted only by the longitudinal depression, but, with increase in size, this area becomes distinctly flattened as in ACROTRETA. Surface covered with sharp concentric striæ which make a slight upward curve as they cross the foraminal groove.

On the interior a strong apical callosity surrounds the probable position of the foramen. This is somewhat produced anteriorly into a short, sharp ridge, on either side of which lie two other ridges, with evidence of a third on the lateral slopes.

Type, *Conotreta Rusti*, Walcott. (Lower Silurian.)

The single species described occurs in the Trenton limestone of New York and the Utica slate of Kentucky.

Discinopsis, Matthew. 1892.

(Plate 3, Figs. 20, 21.)

Shell subcircular in outline. Surface depressed-conical, apices excentric, not marginal. Pedicle-valve with the apex truncated

by a circular foraminal aperture (?). The interior of this valve is characterized by a pair of deep, diverging furrows, passing forward from the beak or internal foraminal opening, in broad curves which converge toward the anterior margin but without meeting. These furrows inclose a thickened and somewhat elevated central area, which, in the subumbonal region, is apparently free, projecting for a short distance, like a narrow, triangular shelf, beneath which the foramen probably opened. A faint longitudinal ridge passes from the apex of the shelf to the anterior margin.

Shell-substance tenuous, apparently corneous. External surface covered with more or less prominent, sometimes lamellose concentric growth-lines, crossed by fine, gently curved, radiating striæ which are usually more prominent when the concentric lines are exfoliated.

Type, *Discinopsis Gulielmi*, Matthew. (Cambrian.)

A single species from the St. John group of New Brunswick.

Linnarssonia, Walcott. 1885.

(Plate 3, Figs. 22, 23.)

Shells transversely ovate or subcircular; valves convex. Pedicle-valve with somewhat elevated submarginal apex, perforated by a circular foramen; without cardinal area or thickened cardinal margin. On the interior there is a conspicuous mammiform tubercle surrounding the opening of the foramen, and two small posterior submarginal tubercles.

In the brachial valve are similar tubercles, though less conspicuously developed; between them lies an axial ridge which is broadened over the central portion of the shell: at the sides are shorter, divergent ridges.

Shell substance calcareo-corneous; lamellar. Surface smooth or with concentric growth-lines.

Type, *Linnarssonia transversa*, Hartt (sp.).

Distribution. Cambrian—(?), Lower Silurian (New York, New Brunswick, Canada, Sweden, Wales).

Mesotreta, Kutorga. 1848.

(Plate 4, Fig. 21.)

Shell patelliform, depressed-conical; apex central, perforated by a foramen; no cardinal area or flattening (?). Surface orna-

mented by concentric growth-lines bearing spines. Pedicle-valve only known.

Type, *Mesotreta tentorium*, Kutorga (Lower Silurian. Russia.).

Trematobolus, Matthew. 1893.

Shell biconvex; valves lenticular. Pedicle-valve with a low, striated hinge-area, the anterior margin of which bears two small articulating apophyses or teeth. Foramen in the center of the shell, opening obliquely backward; between it and the apex is a long tapering groove, with a corresponding ridge on the interior. Muscular scars submarginal, divisible into a posterior and anterior pair.

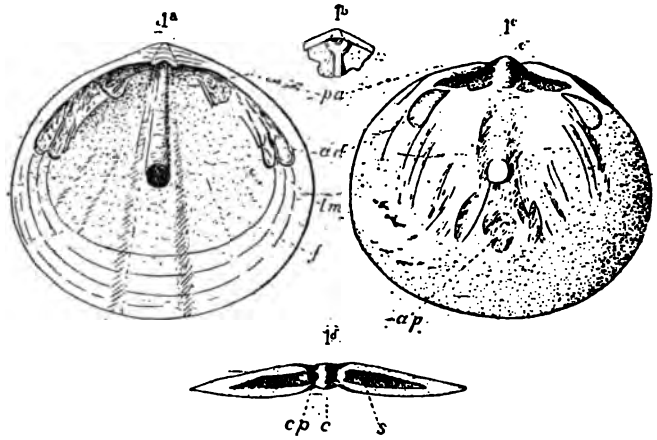


FIG. 263.— *Trematobolus insignis.* 1*a*, interior of pedicle-valve; 1*b*, internal cast of brachial valve; 1*c*, cardinal view of brachial valve; 1*d*, inside of beak of pedicle-valve; *pa*, posterior adductors: *ad*, adjustors; *lm*, lateral muscles; *t*, teeth; *f*, foramen; *s*, sockets; *c*, cardinal process; *cp*, cardinal pits. (MATTHEW.)

Brachial valve, with long, narrow dental sockets and distinct cardinal process. Anterior and posterior muscular scars submarginal and less remote than in the opposite valve.

Surface covered with fine concentric growth-lines and faint traces of radial striæ.

Shell substance calcareo-corneous (?)

Type, *Trematobolus insignis*, Matthew.

Distribution. St. John group; Hanford Brook, New Brunswick.

Siphonotreta, de Verneuil. 1845.

(Plate 4, Figs. 22–26.)

Shell elongate-oval, inequivalve; valves unarticulated. Pedicle-valve the more convex, with a straight, elevated, conical, and perforated beak, the circular foramen opening at the apex and

communicating with the interior of the shell by a tubular canal, which narrows slightly as it passes inward. No cardinal area or deltidium is present, the growth-lines passing between the beak and the posterior margin as elsewhere on the shell. Brachial valve depressed-convex; beak marginal; posterior margin regularly arched and thickened. Interior of pedicle-valve with muscular impressions confined to the umbonal region. Adjacent to the opening of the sipho, and just within the cardinal margin lie two elongate scars which are accompanied on either side by broader, somewhat expanded or flabellate, simple and less distinct impressions. Directly in front of the middle pair and in the axis of the shell lies a small central scar, and at either side of it a transversely elongate impression. These latter impressions are distinctly separated from the former by a transverse ridge.

In the brachial valve the impressions are equally concentrated, the entire muscular area being bounded on its posterior margin by a prominent ridge which, at the sides, merges into a compound lateral scar. The central portion of the area is much depressed and is divided axially by a narrow ridge or septum.

Shell ornamented with concentric lines and ridges, the epidermal layer bearing hollow spines, which are distended at the base. Shell-substance calcareo-corneous, the layers beneath the epidermis being punctured by radiating and branching tubules. These layers are concentric and not parallel to the internal surface.

Type, *Siphonotreta unguiculata*, Eichwald.

Distribution. Lower — Upper Silurian (Baltic Provinces, England, Scotland, New York, Minnesota).

Schizambon, Walcott. 1884.

(Plate 4, Figs. 16–20.)

Shell ovate or oblong; pedicle-valve the more convex, with a short obtuse marginal beak. Foramen in front of the beak, oval in outline and connected with the apex by a tapering groove or progressive cicatrix. Interior of both valves with faint diverging lateral ridges indicative of muscular areas.

Surface covered with concentric growth lines which may be spiniferous. Shell substance calcareo-corneous.

Type, *Schizambon typicalis*, Walcott. (Lowest Silurian [Primordial ?]).

Species having the pedicle-passage situated anteriorly as in *S. typicalis*, but having it developed as a tube, as in SIPHONOTRETA, have been referred provisionally to SCHIZAMBON (*S. fissus*, Kutorga, *S. Canadensis*, Ami). These are much larger and more strongly spinose shells than *S. typicalis*, and also occur in faunas of later age. (Trenton.)

Helmersenia, Pander. 1861.

(Plate 4, Figs. 6, 7.)

Shell having the general form of OBOLUS, with a conspicuous cardinal area depressed in the center by a broad low pedicle-groove (?). Apex of the pedicle-valve truncated by a circular opening, which is not produced into an internal tube. Muscular impressions indistinct.

No specific name has been proposed for the typical form. (Lower Silurian of Russia.)

Orbicella, D'Orbigny. 1849 (1847 ?).

(Plate 4, Figs. 8–10.)

Synonym: *Keyserlingia*, Pander. 1861.

Shell inequivalve, subcircular or oval. Pedicle-valve more or less conical with an excentric apex, from which diverge posteriorly two low ridges inclosing a flattened triangular area divided in the center by a vertical fissure. The lines of growth cross the hinge-line, forming in the center a faintly depressed triangular groove, as in HELMERSENIA and OBOLUS. In the interior of the valve a closed tube is continued from the external fissure, in the axial line. The first one-third of this tube is swollen and thickened, but thenceforward it passes, with parallel sides, to the anterior margins, where it is probably closed. Brachial valve more depressed, its greatest convexity being in the center. Cardinal area as in the opposite valve, but narrower. A closed tube, beginning in a swelling just in front of the cardinal line, is continued from the center of the shell to the anterior margin as an open channel.

Type, *Orbicella Buchi*, de Verneuil (sp.). (Lower Silurian of Russia.)

Discinisca, Dall. 1871.

Synonym; *Discina*, of most authors.

Shells orbicular; brachial valve the more convex; pedicle-valve more or less flattened, concave or depressed. Apices of both

subcentral or subposterior. Pedicle-valve with a small septum as in DISCINA, behind which is an impressed disc or area, externally concave and internally elevated. This is perforated by a longitudinal fissure, extending from a short distance behind the septum nearly to the posterior margin, which is often slightly indented behind it. Shell more or less horny in texture, minutely tubulose. Brown or yellowish in color. Animal with labial folds united. Spiral arms free, their apices being directed toward the pedicle-valve. Oral cirri long and flexible; setæ of the mantle stiff and brittle. Adductor muscles, four; sliding-muscles also four.

Type, *Discinisca lamellosa*, Broderip (sp.).

Distribution. American seas (Atlantic, Pacific, Carribean), China. Fossil: Mesozoic (?) to Tertiary.

Discina, Lamarck. 1819.

Synonym, *Orbicula*, Sowerby. 1818 (not Cuvier. 1798).

Shell orbicular, calcareo-corneous, thick, impunctate, lamellar. Valves convex. A small, sharp, longitudinal septum rises from the center of the lower or pedicle-valve, of a subtriangular shape, covering and hiding a small tubular perforation of the apex of the shell. This perforation is very oblique, and from its internal opening a groove extends backward nearly half-way to the posterior border of the shell. The anterior muscular scars meet in front of the septum and form a semilunar elevation with the points directed backward. The posterior scars in the lower valve are small and widely separated. On the external surface the foramen appears nearly in the middle of the shell and the furrow is continued anteriorly for a short distance. Upper or brachial valve convex, apex subcentral; a slight median longitudinal callus internally. There is no strongly impressed disk about the foramen as in DISCINISCA; color brownish yellow.

FIG. 264.—Vertical section of the pedicle-valve of *Discina striata*. After DAVIDSON.

Type, *Discina striata*, Schumacher.

Habitat. Cape Palmas, West Africa. (Recent: but one species known.)

Orbiculoidea, D'Orbigny. 1847.

(Plate 5, Figs. 11–17.)

Synonym; *Discina* of authors. Not *Orbiculoidea*, Davidson. 1856.

Shells subcircular or subelliptical in outline, inequivalve. Apices excentric. Pedicle-valve depressed-convex or flattened, with the apex slightly elevated and inclined posteriorly. On the exterior of the valve a narrow pedicle-furrow, abruptly intercepting the ornamentation but not penetrating the substance of the shell, begins just below and behind the apex, extends over a greater or less portion of the radius of the valve, and, at its distal end, is produced into a short tubular sipho, which traverses the substance of the shell obliquely backward, emerging on the interior surface, where it produces a narrow groove, and usually terminates before reaching the margin of the valve. On the interior, the position of the external groove is marked by a thickened ridge extending from the apex, and this is continuous with the thickened margins of the internal groove, which, in advanced age, may become so developed as to envelop this groove, except at its outer end.

FIG. 265 — Vertical section of the pedicle-valve of *Orbiculoidea*.

The larger or brachial valve is depressed-conical, with the apex more strongly directed backward than in the opposite valve. The interior shows a fine longitudinal ridge or septum extending from the apex forward. Otherwise the internal markings are not satisfactorily known.

Shell substance composed of alternating lamellæ of corneous and mineral matter, the latter often removed in fossilization, making the shell appear essentially phosphatic. Surface ornamentation usually consisting of fine, crowded or distant, sometimes lamellose, concentric lines, occasionally crossed by radiating lines or ridges.

Type, *Orbicula Morrisi*, Davidson. (Wenlock limestone.)

Distribution. Lower Silurian — Cretaceous (?).

Subgenus **Schizotreta**, Kutorga. 1848.

(Plate 5, Figs. 1–4.)

Shells as in *Orbiculoidea* but having the relative convexity of ıe valves reversed, the pedicle-valve being the more convex.

Type, *Schizotreta elliptica*, Kutorga. (Lower and upper ilurian.)

Subgenus **Rœmerella**, Hall. 1892.

(Plate 5, Figs. 9, 10.)

Brachial valve convex; pedicle-valve concave.

Type, *Rœmerella grandis*, Vanuxem (sp.) (Hamilton group = iddle Devonian.)

Subgenus **Œhlertella**, Hall. 1892.

(Plate 5, Figs. 5–8.)

Contour as in ORBICULOIDEA. Attachment aided by the pro-cting margin of the brachial valve. Pedicle-area conspicuously evated; pedicle-passage an open fissure extending to the margin the valve. Floor of the pedicle-passage (listrium) tripartite. uscular scars not observed. External surface covered with ncentric striæ.

Type, *Œhlertella pleurites*, Meek (sp.) (Waverly sandstone = wer Carboniferous.)

Subgenus **Lindstrœmella**, Hall. 1892.

(Plate 5, Figs. 18, 19.)

Shells with outline, contour and pedicle-characters as in ORBI-ILOIDEA. Brachial valve with a faint median septum and two rong approximiting ridges or muscular fulcra, beginning just hind a transverse line passing through the apex and rapidly nverging to meet the median septum. Anterior adductor scars ing between these ridges and the median septum; a circular uscular scar at the posterior extremity of each ridge.

In the pedicle-valve, the foramen has essentially the structure ORBICULOIDEA, but its distal margins, though lying in close xtaposition, appear not to have been united.

Type, *Lindstrœmella aspidium*, Hall. (Hamilton group = iddle Devonian).

Trematis, Sharpe. 1847.

(Plate 6, Figs. 1–8.)

Shell subcircular or transversely oval in outline. Pedicle-valve unevenly convex, more or less depressed over the posterior region; apex at, or behind the center; directly beneath it begins the pedicle-fissure, which transects the shell, vertically widening to posterior margin with straight or outwardly curving edges. Brachial valve evenly convex, with its apex marginal and slightly projecting. On the interior, the pedicle-valve shows a faint median furrow extending from the angle of the fissure to the apex of the shell; this groove widens at its apical termination and may represent a point of muscular attachment. The sides of the fissure are often thickened by callosities similar to those sometimes seen in species of ORBICULOIDEA. From the apex of the valve extend radiating and branching vascular sinuses.

In the brachial valve the posterior margin is much thickened and broadly grooved to allow the extrusion of the pedicle. This thickening does not take the form of a cardinal area or shelf, but is rather a callosity closely appressed against the interior surface of the shell, the central portion being projected beyond the margin of the pedicle-valve. Directly below and in front of this area are two transversely elongate scars, adjustors or posterior adductors, which are usually partly concealed by the progressive overgrowth of the cardinal thickening. A faint median septum begins between these scars and passes forward, becoming more prominent over the tongue-shaped median elevation which separates the large central scars. These impressions are oblique and are not simple, each appearing to be composed of two, if not three distinct scars, making a posterior, a median and an anterior pair. What appears to be the posterior pair is small, and sometimes quite sharply defined, the central pair very much larger, and the anterior pair narrow, situated at either side of the angle of the median callosity and separated by its apex. The specialization of the first of these scars is not satisfactorily established; the entire impression is deeply excavated. In some well preserved specimens, there is also evidence of external, marginal scars lying just in front of the outer ends of the posterior adductors.

Surface of both valves more or less completely covered by a beautiful ornamentation consisting of punctures or small pittings

of various depth, arranged either in quincunx (*T. terminalis*) or in radiating rows; in the latter case they may be distant from one another without intervening ridges (*T. umbonata*), or lie in radiating furrows, when they are either circular (*T. millepunctata*) or subrectangular (*T. Ottawensis*).

Shell-substance composed of an outer calcareous layer with a series of inner corneous lamellæ. The outer layer varies in thickness in different species, and is coarsely punctated by the pittings constituting the surface ornamentation. The corneous layers are impunctate.

Type, *Trematis terminalis*, Emmons (sp.).

Distribution, Lower (to upper?) Silurian.

The species are largely American and mainly confined to the faunas of the Trenton and Hudson River groups.

Schizocrania, Hall and Whitfield. 1875.

(Plate 6, Figs. 9–13.)

Shells sub-circular in outline, inequivalve, unarticulated. Pedicle-valve flat or concave; apex subcentral. A deep triangular notch extends from just behind the beak to the margin, where its arc is equal to about one-sixth of the periphery. The apex of this broad pedicle-notch is occupied by a triangular transverse plate or listrium varying in size with the age of the shell, but extending for one-fourth to one-third the length of the opening. Surface marked by concentric growth-lines. On the interior no muscular impressions are visible. Brachial valve more or less convex, with the beak marginal. External surface radiately striated. The interior bears a pair of strong posterior adductor scars, lying close together in the unbonal region; their outline is elongate-ovate, indicating a progressive increase in size, and they frequently appear to be divisible into anterior and posterior elements. In front of them, at about the center of the valve, are the small and faint anterior adductor impressions. A low median ridge extends from the apex to beyond the center of the valve. External surface marked by elevated striæ radiating from the beak.

Substance of the shell composed of perlaceous calcareous laminæ which constitute the most of the shell. The inner layers appear to be corneous. All are impunctate (?).

Type, *Schizocrania filosa*, Hall.

Distribution. Lower Silurian to (?) Devonian. The genus is American and the typical species are found in the fauna of the Hudson River group.

Crania, Retzius. 1781.

(Plate 6, Figs. 14-28.)

Synonyms. *Numulus*, Stobœus, 1732; Waller, 1778; *Anomia*, Linné, 1760; *Ostracites*, Beuth, 1776; *Patella*, Müller, 1776; *Criopus*, *Criopoderma*, Poli, 1791. 1795; *Orbicula*, Cuvier, 1798; Lamarck, 1799; *Orbicularius*, Duméril, 1806; *Craniolites*, Schlotheim, 1820; *Choniopora*, Schauroth, 1854.

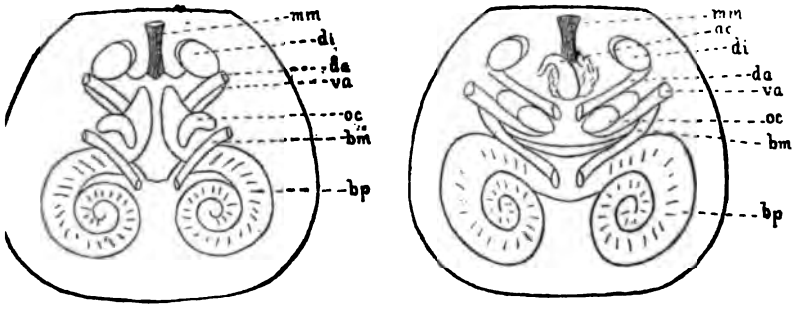
Shell inequivalve, inarticulated, without perforation for a pedicle; subcircular in outline, generally somewhat transverse across the posterior margin; attached by the apex or the entire surface of the lower valve. Ventral or lower valve depressed-conical or conforming to the surface to which it is attached. Dorsal or upper valve more or less conical with a subcentral, posteriorly directed apex. External surface of the valves usually smooth, sometimes spinose or with concentric or radiating striæ. In the interior of both valves are two pairs of large adductor scars, the posterior of which are close upon the margin and widely separated, the anterior near the center of the shell and close together, more approximate in the lower than in the upper valve. These posterior scars are often strongly elevated on a central callosity which surrounds their broad and thickened margins. Impressions of the pallial genital canals anterior. The margin of the lower valve is usually coarsely digitate.

Shell-substance calcareous; strongly punctated by vertical canals which become subdivided toward the epiderma lsurface.

Animal provided with two spiral arms, whose apices are directed toward the dorsal valve. The alimentary canal forms a convolution on the right side, the anus opening near the center of the ventral valve. Liver large; genital glands six in number, two in each mantle lobe and two in the visceral cavity. Mantle without marginal setæ.

Type, *Crania craniolaris*. Linné.

Distribution. Lower Silurian to Recent (Northern Atlantic, Mediterranean, Caribbean, Florida, Japan).



Crania anomala. After HANCOCK.

FIG. 266.— Dorsal surface of the animal. FIG. 267.— Ventral surface.

m, mesenteric muscle; *di*, divaricators; *da*, dorsal adjustors; *va*, ventral adjustors; *oc*, occlusors; *bm*, brachial muscles; *bp*, brachial process; *ac*, alimentary canal (According to JOUBIN, this organ should have a median, not lateral termination).

Subgenus **Ancistrocrania**, Dall. 1877.

(Plate 7. Figs. 1, 2.)

(Synonym; *Cranopsis*, Dall. 1871.)

Lower valve attached; upper valve with two internal apophyses r muscular fulcra diverging from the apex.

Type, *Ancistrocrania Parisiensis*, Defrance (sp.). Cretaceous.

Subgenus **Craniscus**, Dall. 1871.

(Plate 7, Fig. 3.)

(Synonym; *Siphonaria*, Quenstedt. 1851.)

Attached valve divided by a transverse and a longitudinal ptum into three cells, the posterior containing the muscular npressions.

Type, *Craniscus tripartitus*, Münster (sp.). Jurassic.

?Subgenus **Pseudocrania**, McCoy. 1851.

(Plate 7. Figs. 11–13.)

(Synonym; *Palæocrania*, Eichwald. 1860.)

Shell free; valves convex; margins of contact broad and flat; pper valve with three pairs of muscular scars, the largest sub- arginal; a smaller median pair, and an anterior pair with the embers in apposition. In the lower valve the median and

anterior scars are coalesced; the cardinal scars as in the other valve.

Type, *Pseudocrania antiquissima*, Eichwald (sp.). (Lower Silurian.)

Subgenus **Craniella**, Ehlert. 1888.

(Plate 7, Figs. 4, 8.)

Shell somewhat irregular, outline subcircular or subquadrangular. Lower valve thin, adhering by its entire surface; upper valve conoidal, more or less elevated; apex subcentral, posterior; interior of the upper valve without a well defined border; impressions of the adductors large, very distinct, four in number, of which the posterior two are quite distant, the anterior two subcentral, somewhat smaller, closely approximate or even confluent; from near each of the posterior impressions starts a vascular sinus, which is broad, strongly sinuous near its point of departure, narrowing gradually in following the contour of the valve, emitting from its marginal side dichotomizing secondary branches.

FIG. 268.—*Craniella Meduanensis*. After EHLERT. Internal cast of upper valve.

Type, *Craniella Meduanensis*, Ehlert.

Distribution. Lower Silurian to Devonian.

Subgenus **Cardinocrania**, Waagen. 1885.

(Plate 7, Figs. 9, 10.)

Shells attached; posterior margin straight, set off from the rest of the outline by strong post-lateral indentations. Interior with a thin triangular plate, broad at its base where attached in the cardinal region; supported by a low median septum. Muscular impressions unknown.

Type, *Cardinocrania Indica*, Waagen. (Permo-carboniferous, India.)

Pholidops, Hall. 1859.

(Plate 7, Figs. 14–22.)

Synonyms: *Patellites*, Schlotheim, 1820; *Craniops*, Hall. 1859.

Shells small, patelliform, equivalve, equiconvex, inarticulate, unattached. Outline oval or subelliptical; apex subcentral,

excentric or marginal, sometimes terminal and produced. Surface marked by strong concentric, often lamellose lines of growth, which are crowded on the posterior, and distant on the anterior portions of the valves; these are sometimes crossed by faint interrupted radiating lines. On the interior, the surfaces of contact make a broad, smooth, flat or slightly convex border, somewhat broader in front than behind. The muscular and visceral area occupies a sharply defined and very limited space in the apical portion of each valve. In both valves it is of essentially the same size and ovate-triangular in outline, the apex of the triangle pointing forward and usually surrounded by a conspicuous callosity.

The ventral (?) valve bears two well defined central adductors occupying the same relative position as in CRANIA; these impressions are usually simple, but appear to be sometimes complicated by association with ill-defined scars of the anterior muscles. The posterior adductors or divaricators are situated at the basal angles of the muscular triangle, and are distant from the posterior margin. The linear parietal scars are very strong, the posterior being more or less distinctly lobate, the anterior generally straight or rounding about the central adductors. In the opposite or dorsal (?) valve the scars have essentially the same arrangement; the anterior adductors, however, are separated by elongate median scars (anteriors) which traverse the elevated callosity surrounding the anterior margin of the area. The posterior scars are often more widely divergent than in the other valve. Shell-substance calcareous and impunctate (?).

Type, *Pholidops squamiformis*, Hall.

Distribution, Lower Silurian to Lower Carboniferous.

II.

Brachiopoda Articulata.

Valves articulated; intestine terminating in a blind sac; shell-substance essentially calcareous.

So far as our knowledge of the fossil species extends, there are very few of the forms included in this division to which the above definition does not apply. Several genera show very considerable modification of the articulating apparatus, but with rare exceptions these modifications in each group appear to be progressive, extending along certain lines of development and finally acquiring an extravagant manifestation, which may terminate abruptly or be followed by the degeneration and obsolescence of some of the parts.

For example, the articulating apparatus in STROPHEODONTA, PRODUCTUS, etc., may be regarded as in a degenerative condition, and on this account these genera are sometimes placed near the base of the articulate division, though the type of structure exhibited by them is much more highly modified than in ORTHIS and its immediate allies in the older rocks.

The mode of articulation in PRODUCTUS appears to have come legitimately from the progress and development of some portions of the articulating apparatus on the one hand, and the obsolescence of other characters, which appear in the earlier forms of strophomenoid shells, and have become modified in their progress through the chonetids. While this may be regarded as a degeneration, it is also a progressive modification.

Of the various designations which have been proposed with a signification equivalent to Professor HUXLEY's term for this subdivision of the BRACHIOPODA, are ARTHROPOMATA, OWEN; CLISTENTERATA, KING; while BRONN made use of the two names TESTICARDINES and APYGIA.

Orthis, Dalman. 1828.

(Plates 9-12.)

Synonyms: *Hysterolithes*, Schlotheim, 1820; *Orthambonites*, Pander, 1830.

Shell subcircular, subovate or subquadrate in outline. Valves more or less convex, the smaller or brachial valve being sometimes nearly flat or slightly concave. Hinge-line straight and equal to, or shorter than the greatest width of the shell. Cardi-

nal area well developed on each valve and usually divided by an open triangular delthyrium. Beaks more or less incurved. Surface covered by radiating costæ or fine striæ, with faint evidence of median fold and sinus.

In the interior of the pedicle-valve the large hinge-teeth are supported by dental plates which are more or less conspicuously developed, frequently resting upon the bottom of the valve. The bases of these are continued as a low elevation about the muscular area. This muscular impression is divided longitudinally by an inconspicuous median ridge and the larger expansions on each side were probably occupied by the diductor muscles; within these and lying close against the median ridge are the adductors, while the pedicle muscles covered the posterior deltidial portion of this area.

In the interior of the brachial valve the apex of the deltidial cavity bears a more or less developed cardinal process or callosity, which, in the typical group, is elongate and usually simple at its termination. The dental sockets are deep and their inner walls support short divergent crura. The muscular impression is more or less distinctly quadruple, being divided longitudinally by a median ridge extending forward from the cardinal process, and transversely by fainter ridges. This quadruple scar marks the place of attachment of the adductor muscle.

Ramified vascular markings are often retained over the pallial area, the principal trunks diverging from the median region and nearly following the curve of the anterior margin of the shell. Between these and the adductor impressions the markings of the ovarian areas are sometimes visible.

Shell-structure fibrous and impunctate in the typical group.

This extensive genus has been divided into the following groups or subgenera:

Orthis, Dalman, *sensu stricto.*

I. Group of ORTHIS CALLACTIS, Dalman.

(Plate 9, Figs. 1–7.)

Shells plano-convex in contour; costæ, strong, sharp and comparatively few, rarely if ever bifurcating; the cardinal area on the pedicle-valve elevated and somewhat incurved; dental lamellæ slightly developed, not extending the entire length of the umbonal cavity. The cardinal process on the brachial valve is

an elongate, vertical plate, extending from the apex the whole length of the delthyrium, thus longitudinally dividing the deep deltidial cavity. It is usually simple, both on the outer edge and at its distal extremity. Shell structure compactly fibrous and impunctate, except for large oblique tubules penetrating the external layers. (Lower — Upper Silurian.)

Plectorthis, Hall. 1892.

II. Group of ORTHIS PLICATELLA, Hall.

(Plate 9, Figs. 8-10.)

Valves subequally convex. Cardinal area of pedicle-valve low; plications strong, simple or duplicate. Shell substance impunctate. (Lower Silurian — (?) Lower Devonian.)

Dinorthis, Hall. 1892.

III. Group of ORTHIS PECTINELLA (Conrad, MS.), Emmons.

(Plate 9, Figs. 11-15.)

Relative convexity of the valves reversed. Surface with strong, rarely bifurcating plications. Delthyrium sometimes partially closed. Muscular area in pedicle-valve subquadrate, bounded by extensions of the dental lamellæ. In the brachial valve the muscular impressions are obscure; cardinal process erect, broad and frequently bilobed on its posterior face. Shell structure impunctate. (Lower Silurian.)

Plæsiomys, Hall. 1892.

IV. Group of ORTHIS SUBQUADRATA, Hall.

(Plate 9, Figs. 16-20.)

Valves with reversed convexity. In the interior of the pedicle-valve there is a large quadrate muscular scar, with a tendency to bilobation by the lateral extension of the diductor impressions. The subdivision of this area into separate scars is frequently very distinct. In the brachial valve the cardinal process is thickened and erect at its posterior extremity, being distinctly crenulate on the summit and posterior face. The surface striæ are tubulose and the shell-structure fibrous-impunctate. (Lower Silurian.)

Hebertella, Hall. 1892.

V. Group of ORTHIS SINUATA, Hall.

(Plate 10, Figs. 1-4.)

Shells with convexity of the valves reversed. Surface covered with numerous fine, rounded, closely-crowded plications, crossed by lamellose growth-lines. On the interior of the pedicle-valve

the teeth are large and supported by thick lamellæ which are continued as a strong ridge around a short obcordate muscular area. This area is medially divided by a prominent ridge upon the summit of which lies the linear scar of the adductors. The flabellate lateral impressions are sometimes divisible into their two components, diductors and adjustors, and in old individuals the impression of the pedicle-muscle is often distinct.

In the brachial valve the dental sockets are narrow and are inclosed beneath, and on the inner side, by the strong crural plates. The cardinal process is elongate and simple, sometimes thickened, often crenulate, but not lobed at its posterior extremity. The process unites with the inner basis of the crural plates and is produced forward as a median ridge dividing the four muscular scars, which are distinctly developed only in old shells.

Shell-structure fibrous-impunctate; the plications of the surface sometimes tubulose.

(Lower — Upper Silurian.)

Orthostrophia, Hall, 1883.

VI. Group of ORTHIS STROPHOMENOIDES, Hall.

(Plate 10, Figs. 5–8.)

Contour and surface as in HEBERTELLA. In the interior of the pedicle-valve the muscular area is deeply excavated, and limited almost to the narrow space between the dental lamellæ. The adductor scars are extremely minute and linear, while the diductors occupy the rest of the area. In the opposite valve the muscular area is similarly confined but the quadrilobate character of the impression is very decided. The lateral components are divided by a strong median ridge, and the entire area is deeply impressed in the substance of the shell. The cardinal process is elongate and simple at its posterior extremity, the crural plates and crura strong.

The vascular and ovarian markings are conspicuous. In the pedicle-valve two or three large vascular trunks originate near the anterior edge of the muscular area, divide a few times in their passage over the pallial region, the branches rapidly multiplying near the margin. In the opposite valve the main sinuses are four in number, originating in pairs at the ante-lateral mar-

gins of the anterior adductors. The outer member of each pair curves quite abruptly toward the cardinal angle, while the inner members curve outward and then inward, all ramifying as they approach the margins of the shell. The umbo-lateral spaces inclosed by the curvature of these sinuses in both valves, and the central space in the brachial valve, are covered with linear dendritic ovarian striæ. Shell substance impunctate.

(Lower Devonian.)

Platystrophia, King. 1850.

VII. Group of ORTHIS BIFORATA, Schlotheim (sp.).

(Plate 10, Figs. 9–13.)

Contour spiriferoid; hinge-line and area long and straight, nearly equally developed on the two valves. Both valves very convex, the brachial being the more so, and bearing a very strong median fold corresponding to a deep sinus on the opposite valve. Surface of valves marked by strong, sharp plications, which extend over the fold and sinus, and the external surface is finely granulose, the latter feature being rarely well retained. Delthyrium open in both valves, being somewhat larger in the pedicle-valve, and in old and gibbous shells of *Orthis lynx* it has often encroached to a considerable extent upon the umbonal region of the valve. Teeth thick and very prominent; muscular area comparatively small, but usually deeply excavated in the substance of the shell, and not readily divisible into the component scars. The cardinal process of the brachial valve is a simple linear ridge, always small and sometimes nearly obsolete. Dental sockets comparatively small; crural plates large and thick, uniting at their inner bases and produced into a prominent median ridge. Muscular area quadruplicate. Shell-structure very compact and finely fibrous, without punctation.

(Lower — Upper Silurian.)

Heterorthis, Hall. 1892.

VIII. Group of ORTHIS CLYTIE, Hall.

(Plate 11, Figs. 1–3.)

Contour leptænoid. Shell transversely oval, with a straight hinge-line and rounded cardinal extremities; its form is depressed plano-convex, the convexity of the pedicle-valve being slight.

The cardinal area is about equally developed on each valve. Surface ornamented by fine, rounded, radiating striæ between each two of which are from two to six much finer radiating lines; all these are crenulated by exceedingly faint growth-lines.

The interior of the pedicle-valve has short teeth with prominent extremities, and inconspicuous dental lamellæ. The muscular impression is large and consists of a small adductor scar situated centrally, and two lateral scars which are flabellate and greatly elongated, but not uniting in front and inclosing the adductor, as is usual in typical forms of ORTHIS. These lateral scars are divided into subordinate impressions, of which the outer posterior members may represent the adjustors. In the brachial valve the dental sockets are obscure, the crural plates oblique, terminating abruptly at the bases of the crura, their lower part being continued in a low ridge surrounding a short subcircular muscular area, which is very obscurely quadrilobate. The cardinal process has a vertical, sharp, simple, posterior edge, but is much thickened where it unites with the crural plates, and is produced along the muscular area as a prominent median ridge. From the antelateral margins of the muscular area radiate six low, somewhat sinuous ridges of similar character to those frequently seen in members of Group XI. Both valves are considerably thickened just within the margins, as in many strophomenoids.

The shell-structure is finely fibrous and perforated by minute punctations which are in general sparsely developed, but most distinctly arranged in radiating rows corresponding to the surface striæ.

(Lower Silurian.)

Bilobites, Linné. 1775.

Synonym: *Dicelosia*, King. 1850.

IX. Group of ORTHIS BILOBA, Linné.

(Plate 10, Figs. 14–19.)

Shells small, strongly bilobed. Hinge-line short; teeth and sockets obscure; cardinal process small and simple. Crural plates thin and very long, often extending as far forward as the commencement of the lobation. Muscular area indistinct, larger in the brachial, than in the pedicle-valve. Shell-substance fibrous

and punctated by coarse tubules apparently arranged in radiating rows.

(Lower Silurian — Lower Devonian.)

Dalmanella, Hall. 1892.

Group of ORTHIS TESTUDINARIA, Dalman.

(Plate 11, Figs. 4–17.)

Shells plano-convex or subequally biconvex. Pedicle-valve usually the deeper, often gibbous, elevated at the umbo and arched over the cardinal area. Hinge-line generally shorter than the greatest width of the shell. In many of the species there is a more or less conspicuous, undefined median fold and sinus on the pedicle and brachial valves respectively. Surface covered with fine, rounded bifurcating striæ.

In the pedicle-valve the teeth are quite prominent, thickened at their extremities and supported by lamellæ which are produced forward, circumscribing a rather short suboval or subquadrate muscular area, which is more or less distinctly defined in different species and in different conditions of the shell.

In the brachial valve the cardinal process extends forward to the bases of the crural plates, where it is broadened and continued thence as a median ridge separating the muscular impressions. The inner surface of this process is divided by a faint median furrow which produces two lobes at the posterior extremity, and each of these lobes is again divided, making the process quadrilobate. Sometimes the inner divisions of the two main lobes have coalesced, producing a strong median lobe and thus making the process appear trilobate. In some species, at maturity, and in others from abnormal growth, this process becomes a broad plug, which fills the entire delthyrial opening. The dental sockets are small, the crural plates often greatly elevated, especially in the plano-convex forms, and they are not usually produced into a ridge about the muscular area, but end abruptly. Muscular impressions quadruplicate, sometimes with radiating ridges extending from the lateral and anterior margins.

Shell-substance finely fibrous and punctate.

(Lower Silurian — Upper Silurian.)

Rhipidomella, Œhlert. 1890.

Synonym; *Rhipidomys*, Œhlert. 1887.

XI. Group of ORTHIS MICHELINI. Léveillé.

(Plate 12, Figs. 1–13.)

Shell subcircular in outline, biconvex and sublenticular, with the brachial valve somewhat the deeper. Hinge-line short, cardinal area narrow, especially on the brachial valve. The surface bears a slight median depression on each valve, and is covered with fine, rounded, subequal striæ which are hollow, often opening upon the surface; these openings probably represent the broken bases of short tubular spines.

The pedicle-valve bears two strong diverging teeth, planted firmly upon the valve at the bottom of the delthyrium, and extending upward and outward at their extremities; from their bases a more or less strongly defined curving ridge extends forward, bordering the muscular area. The muscular area extends from one-third to five-sixths the length of the valve and is deeply impressed; the pedicle-scar fills the entire rostral cavity; the adductors occupy a small central scar which is completely enveloped by the great diductors. A median ridge arises in front of the adductors, dividing the diductors; sometimes the latter scars rest upon a general anterior flattening of this ridge, and in rare instances the ridge divides the separate components of the adductor impression. The margin of the entire muscular area is thickened and elevated, and outside of this are deeply pitted ovarian markings.

In the brachial valve the dental sockets are deep and narrow, the crural plates extremely prominent, sometimes supporting short crura. The cardinal process is erect, strongly arched on its anterior face, often very thick and greatly elevated; the edge of its posterior face is multilobate, the posterior surface itself having a trilobed appearance. The muscular area is quadruplicate, comparatively small and usually indistinct. A broad, low, median ridge extends forward from the base of the cardinal process. The shell-structure is coarsely fibrous and very strongly punctate, the perforations being large and generally more abundant along the furrows between the striæ.

(Upper Silurian — Upper Carboniferous.)

Schizophoria, King. 1850.

XII. Group of ORTHIS RESUPINATA. Martin.

(Plate 11. Figs. 18–23.)

Shells resupinate or with normal convexity reversed as in Groups IV, V, VI. Surface very finely striate, the striæ being hollow, tubulose and produced into short spines as in RHIPIDOMELLA.

In the pedicle-valve there is a short subquadrate or obcordate muscular area with thickened, elevated margins, and deeply sunk in the substance of the shell; in the opposite valve a less distinctly defined, quadripartite area. In the brachial valve the crural plates are erect and divergent; the cardinal process, which in young shells, has much the same character as in RHIPIDOMELLA, becomes resorbed and thus narrowed with age, making a thin and sharp ridge; concomitant with this change is the formation, in the delthyrial cavity, of one, two or even three minor ridges on each side of the original process, so that in old shells the posterior face of the process appears to be multilobate. In this valve four (rarely six) deep pallial sinuses take their origin at the anterior margin of the muscular area, passing forward as broad, simple, subparallel bands, to near the margin of the valve, where they bifurcate and become arborescent. Shell substance highly punctate.

(Upper Silurian—Coal Measures.)

Orthotichia, Hall. 1892.

XIII. Group of ORTHIS? MORGANIANA, Derby.

(Plate 12, Figs. 14–17.)

External form as in SCHIZOPHORIA. In the pedicle-valve the dental lamellæ are highly developed, between them lying a conspicuous median septum; muscular area not deeply impressed. Shell substance punctate.

(Carboniferous; Brazil, India.)

Enteletes, Fischer de Waldheim. 1830.

XIV. Group of *Enteletes Lamarcki*, Fischer de Waldheim.

(Plate 12, Figs. 18–21.)

Valves strongly inflated; brachial valve the more convex. Surface coarsely ribbed and covered with fine radial striæ. Hinge-line short; cardinal area of pedicle-valve highly

developed. On the interior the pedicle-valve bears strong teeth, highly developed convergent dental lamellæ, and an elevated median septum which extends to the middle of the valve, terminating abruptly. In the brachial valve the crura are recurved over the cardinal line and are supported by strong septa; cardinal process small, erect and multilobate. Muscular scars very faint. Shell substance punctate, tubulose at the surface.

(Carboniferous.)

Billingsella, Hall. 1892.

(Plate 8, Figs. 1, 2.)

Shell transverse; subquadrate or semicircular in outline. Contour concavo—, or plano-convex. Surface sharply striate or plicate. Pedicle-valve the more convex; cardinal area moderately high, vertical or slightly incurved. Delthyrium covered by a convex plate, which, in rare instances, may be minutely perforated at the apex; the teeth are well developed, but the dental plates are continued along the bottom of the umbonal cavity, only near the apex inclosing a small subelliptical muscular area. In the brachial valve the cardinal area is greatly inclined, making an obtuse angle with that of the opposite valve. The delthyrium is partially covered by a convex deltidium which never attains the development seen in the opposite valve, and is often wholly absent.

Type, *Orthis Pepina*, Hall.

Distribution. Cambrian—(?) Upper Silurian.

Protorthis, Hall. 1892.

(Plate 8, Figs 3–7.)

Shells small, transversely subquadrate or semicircular. Hinge-line straight, its length being equal to the greatest width of the valves. Valves unequally biconvex, or sub-planoconvex, the pedicle-valve being the larger. The cardinal area is narrow on both valves, but is higher on the pedicle-valve, and is transected by a broad delthyrium which is closed below by a concave plate apparently produced by the union of the dental lamellæ, which are not continued to the bottom of the valve; teeth distinctly developed. In the brachial valve the cardinal area also bears an open delthyrium; the dental sockets are obscure and the crural

plates small; the latter appear to unite and form a low elevation across the base of the delthyrium. Cardinal process absent or rudimentary in all the specimens examined. Muscular markings in both valves extremely obscure.

Surface marked by distinct plications, with interstitial finer radii, which are crossed by delicate concentric striæ; these are usually accompanied by a low sinus and fold on the brachial and pedicle-valves, respectively; interior very finely papillose. Shell-substance fibrous and apparently punctate.

Type, *Orthis Billingsi*, Hartt. (Cambrian.)

Clitambonites, Pander. 1830.

(Plate 8, Figs. 8, 9.)

Synonyms; *Pronites*, *Gonambonites*, Pander. 1830.

Shells with a subsemicircular marginal outline; convex or subpyramidal in the typical group. Hinge-line straight and forming the greatest diameter of the shell. Pedicle-valve elevated, cardinal area high, vertical, or sometimes incurved, and crossed by a broad delthyrium, which is normally covered by a convex, perforate deltidium. On the interior of the valve the dental lamellæ are very strongly developed, converging and uniting in the median line before reaching the bottom of the valve; thus forming a spondylium, which, with the deltidium, incloses a conical subrostral vault. This plate is supported by a median septum extending for about one-half the length of the valve. Muscular impressions obscure. In the brachial valve the cardinal area is considerably developed, and the delthyrium filled by a conspicuous callosity, against the inner side of which the simple orthoid cardinal process abuts. The dental sockets are large, the crural plates low and continuous with the edges of the delthyrial callosity. A thickened transverse area is formed in the umbonal region by the union of the inner portions of the crural plates with the cardinal process, and thence a broad median ridge is continued forward through the muscular area, which is sharply defined and quadripartite. External surface covered with radiating striæ. Shell-substance impunctate.

Type, *Clitambonites adscendens*, Pander.

Distribution. Lower Silurian.

HEMIPRONITES, Pander, 1830. (Plate 8, Figs. 14, 15.) Shells as in CLITAMBONITES but with shorter hinge-line and subequally convex valves. Type, *H. tumida*, Pander; Lower Silurian).

ORTHISINA D'Orbigny, 1847. (Plate 8, Figs 10–13.) Shells as in CLITAMBONITES but with the cardinal area and chilidium of the brachial valve extravagantly developed. Type, *O. anomala*, Schlotheim (sp.) Lower Silurian).

Subgenus **Polytœchia**, Hall. 1892.

(Plate 8, Figs. 16–20.)

Shell small, subtrihedral in contour. Hinge-line straight, about equaling the diameter of the shell. Pedicle-valve with a high, nearly vertical cardinal area marked with oblique striations parallel to the lateral margins. Delthyrium covered by a narrow, convex plate; the presence of a foramen not determined. On the interior the dental lamellæ are widely separated, and descend along the umbonal cavity for a short distance vertically, thence bending sharply inward and meeting at a low angle in the median line; thus forming, with the deltidium, a conspicuous subrostral vault. This is supported by a stout median septum, and two smaller lateral septa, which meet it at the lines of angulation; the former of these extends for the entire length of the plate, while the latter is free from the accessory septa near its anterior edge. The umbonal cavity of the valve is thus divided into five chambers, and in the lateral chambers there is still another septum, lower than the rest and not extending to the spondylium. The brachial valve is shallow and depressed-convex, with a narrow cardinal area. The delthyrium is very broad with a partially developed covering, the dental sockets are widely separated, the crural plates narrow and nearly parallel to to the hinge-line. The cardinal process is simple, linear and quite prominent, and at its union with the crural plates is a subtriangular thickening which is supported by a low median septum. Surface covered with fine, elevated, radiating striæ, without evidence of median fold and sinus.

Polytœchia apicalis.
FIG. 269.—Transverse section of pedicle-valve, near the apex.

Type, *Hemipronites apicalis*, Whitfield.

(Lower Silurian.)

Scenidium, Hall. 1860.

(Plate 8, Figs. 21–27.)

Synonym; *Mystrophora*, Kayser, 1871.

Shell subpyramidal, somewhat semicircular, with or without median sinus and elevation. Pedicle-valve elevated, subpyramidal; beak straight or slightly arched; muscular impressions undetermined. Cardinal area large, triangular, divided by a narrow fissure, which is sometimes closed at the summit by a concave plate. Brachial valve flat, or varying from depressed-convex to concave. Beak entire, or indented by the foramen; cardinal line straight and usually equaling the width of the shell; crural plates broad and well developed, marked by the imprints of the pedicle muscles, and produced in the middle in a pointed process; the cardinal process extends, as a median septum, through the length of the shell, and may be simple or divided at its anterior extremity. Exterior surface covered with radiating striæ.

Type, *Scenidium insigne*, Hall.

Distribution. Lower Silurian — Middle Devonian.

Orthidium, Hall. 1892.

(Plate 8, Figs. 28–31.)

Shell very small, transverse, having the external aspect of SCENIDIUM. Hinge-line long, making the greatest diameter of the shell. Pedicle-valve the more convex; cardinal area moderately high, with a broad open delthyrium, strong teeth and inconspicuous dental plates; in all respects like the corresponding valve of *Orthis calligramma*. Brachial valve slightly convex; cardinal area very narrow; dental sockets well developed, crural plates very short and erect, coalesced with the cardinal process, which thus becomes a vertical, transverse, subcrescentic plate, at the base of which the shell is somewhat excavated; muscular scar quadruplicate. Surface covered with radiating striæ, which extend over the broad, low sinus and fold in the brachial and pedicle-valves respectively. In the former the sinus makes a prominent median ridge in the interior of the valve. Shell-structure not determined.

Type, *Orthidium gemmicula*, Billings.

(Lower Silurian.)

Leptella, Hall. 1892.

(Plate 13, Figs. 10–12.)

Shells small, normally concavo-convex. Outline semicircular or semielliptical. Hinge-line straight, making the greatest diameter of the shell. Pedicle-valve evenly convex, cardinal area moderately high, delthyrium for most of its extent covered by a convex plate; teeth inconspicuous and unsupported by lamellæ; muscular impressions undetermined. Brachial valve slightly concave; cardinal area comparatively high; the delthyrium filled by the cardinal process, which, as viewed from behind, is divided by a median groove for its entire height. On the cardinal margin this process is double but less conspicuous than the crural plates, which are arched and highly elevated above the hinge-line. They are short, terminate abruptly, and inclose deep sockets. The visceral area is flattened or concave, its anterior margin forming a double curve, from which line the surface of the valve is abruptly deflected. This visceral area is divided by a broad median ridge and its surface covered with fine, sharp radiating lines which end at the line of deflection.

Type, *Leptella sordida*, Billings.

Distribution. Cambrian — Lower Silurian.

Leptæna, Dalman. 1828.

(Plate 13, Figs. 1–4, 6–9.)

Synonym; *Leptagonia*, McCoy, 1844.

Shells plano-convex when young, concavo-convex at maturity; convexity normal. Surface covered by conspicuous concentric corrugations or wrinkles over the flatter portions of the valves. Where these cease the surface is more or less abruptly and often rectangularly deflected, forming a conspicuous anterior slope. The whole exterior is covered with fine, even, radiating, thread-like, tubular striæ, which, in well-preserved specimens, are crenulated by finer concentric striæ. Outline transversely subquadrate or semioval. Hinge-line straight, its length making the greatest diameter of the shell; extremities often subauriculate. Cardinal area narrow, slightly wider on the pedicle-valve, not denticulate. In the pedicle-valve, the delthyrium is covered by a convex deltidium, perforated at the apex by a foramen which is closed at maturity or encroaches upon the apex of the valve.

This deltidium is most conspicuously developed in early stages of growth, when it has the form of a tube or sheath, which character becomes obliterated as maturity approaches, by the increase in the size of the cardinal process, and the deltidial callosity formed about its base. In adult shells the foramen has become inclosed by the substance of the shell, its external opening being an oblique groove in front of the apex of the valve, and its inner aperture appearing in front of the pedicle-scar. Not infrequently the passage is closed at maturity. The teeth are very divergent and quite conspicuous, generally supported by lamellæ which are continued around the subcircular muscular area of the narrow umbonal cavity. The muscular scars consist of a narrow median or adductor, inclosed by flabelliform diductors.

In the brachial valve the area is linear, the delthyrium is progressively filled by the growth of a callosity, which is often deeply grooved, along the center, and sometimes perforated in the line of division between the branches of the cardinal process. The cardinal process consists of two sessile, diverging apophyses which have broad, flat, striated surfaces of attachment, and are extended beyond the hinge-line. The sockets are moderately deep; the crural plates are usually not sharply defined, but are continued in a curving line along the inner surface of the valve, partially embracing a pair of broad, ovate muscular impressions which are marked by aborescent ramifications; recurving and again incurving, these ridges partially surround a pair of smaller muscular areas, lying in front of the first. At the inner base of each branch of the cardinal process there arises a low elevation or callosity, which, extending obliquely forward, and uniting in the center, continues as a narrow median ridge dividing the posterior pair of muscular impressions. This ridge sometimes terminates in a point near the base of the first pair of impressions, and the second pair are separated by a low, slender median septum, which sometimes apparently takes its origin at this point, but which is in fact a continuation from the interrupted posterior ridge, and extends for some distance over the pallial region.

The muscular area, when its features are most distinctly retained, shows the subdivision into the following scars: (*a*) A large posterior pair (the posterior adductors), the surface of which is covered with arborescent ridges; the anterior portion of

each of these scars is smoother than the rest, generally much thickened and often extremely elevated at its outer margins. These may be regarded as accessory elements of the posterior adductors. (*b*) An anterior pair (anterior adductors), situated close together at about the center of the valve. The position of these is generally well defined but their outline is frequently obscure. (*c*) An elongate, narrow median scar, which is apparently divided for its entire length by a faint ridge. In front of the muscular area there are often a number of short protuberances on each side of the median septum, and the anterior pair of scars is frequently obliterated by prominent callosities. At the line of geniculation the interior surface is elevated into a very prominent, sharp, or abruptly rounded crest. Spiral callosities for the support of the brachia, similar to those in DAVIDSONIA and LEPTÆNISCA, have been observed.

Shell-substance strongly punctate.

Type, *Leptæna rugosa*, Dalman.

Distribution. Silurian — Carboniferous.

Rafinesquina, Hall. 1892.

(Plate 18. Figs. 513-18.)

Shells normally concavo-convex. Surface ornamented by radiating striæ, of alternating size, crossed and crenulated by finer concentric striæ. Cardinal margins without denticulations. Interior of the pedicle-valve with the muscular area not strongly limited; consisting of two broad flabellate diductor scars inclosing an elongate, more distinctly defined adductor. The faintness of the limitation of this area is in marked contrast to the sharply defined muscular area in the corresponding valve of LEPTÆNA. In the brachial valve the cardinal process is more closely sessile than in LEPTÆNA, and there is frequently a linear callosity between the branches. The posterior adductor scars have the arborescent markings of *Leptæna rhomboidalis*, and these impressions are the only ones well defined, the anterior scars being narrow and rarely retained with distinctness. From the anterior margin of the muscular area radiates a series of irregular furrows and nodose ridges, which are to some extent of vascular origin.

Type, *Rafinesquina alternata*, Conrad (sp.).

Distribution. Lower — (?) Upper Silurian.

Stropheodonta, Hall. 1852.

(Plate 14, Figs. 1–6.)

Shells normally concavo-convex. Cardinal area common to the two valves, that of the brachial valve narrower or linear; smooth or finely striated longitudinally, sometimes showing through the outer laminæ of the shell, strong, parallel, transverse bars, which project beyond the cardinal margin as short processes, and articulate with a corresponding series of pits in the opposite valve. The earliest species have these denticulations developed only for a short distance on each side of the center, while in the latter faunas they extend the entire length of the hinge-line. In the type-species the delthyrium is usually completely closed by the extension of the shelly laminæ of the area, and on the inside by the formation of a callosity between the apophyses of the cardinal process. Sometimes a low, narrow, convex deltidium is present, and in the early species the delthyrium is frequently open.

From the normal position of the dental lamellæ there extend two diverging, sometimes nearly vertical ridges of variable strength bounding the post-lateral portion of the muscular area, which is not limited by a ridge in front. The entire muscular area consists of two broad flabelliform diductor scars, inclosing an oval adductor which is distinctly divided into anterior and posterior elements. The foramen, dental plates and teeth are obsolete or obsolescent in the Devonian species.

In the brachial valve the delthyrium is also usually closed, the cardinal apophyses are strongly arched into the umbonal cavity of the opposite valve, their surfaces of attachment being sometimes nearly parallel to the plane of the cardinal area of the brachial valve, and often extending beyond it. Small crural plates are always present, though they could not have been functional at maturity. Muscular arrangement similar to that of *Ratinesquina alternata*, the posterior scars being more elongate the anterior pair usually less defined, and all the scars frequently obscured. The anterior muscular fulcra are sometimes developed into very prominent elongate apophyses. The median septum often becomes elevated into a high crest at the center of the valve. Over the pallial region the interior of both valves is strongly papillose. External surface covered with radiating,

sometimes fasciculate striæ; rarely smooth. Shell-substance fibrous, coarsely punctate.

Type, *Strophcodonta demissa*, Conrad (sp.).

Distribution. Lower Silurian (?) — Upper Devonian.

Subgenus **Pholidostrophia**, Hall. 1892.

(Plate 14, Figs. 11–15.)

Shells small; surface smooth or squamous; nacreous. Interior of the brachial valve with three diverging ridges in front of the muscular area. (Type, *P. nacrea*, Hall (sp.). Devonian.)

Subgenus **Leptostrophia**, Hall. 1892.

(Plate 15, Figs. 1–4.)

Shell plano-convex or flat; delthyrium more or less completely closed. In the pedicle-valve are two pustulose diverging ridges, bounding the sides of the muscular area. Cardinal scars broad and flabellate; not distinctly limited anteriorly. (Type, *L. magnifica*, Hall. Devonian.)

(?) Subgenus **Brachyprion**, Shaler. 1865.

(Plate 14, Figs. 7–10.)

Shells with delthyrium open or partially covered; crenulations of the cardinal margin confined to a very limited extent on either side of the fissure.

(Type, *B. Leda*, Billings (sp.). Upper Silurian.)

Subgenus **Douvillina**, Ehlert. 1887.

(Plate 14, Figs. 16–19.)

Shells having a crenulated hinge and flat deltidium. In the pedicle-valve are two small teeth connected with diverging ridges which are strongly elevated in front, and inclose a transverse muscular area. Beneath the beak are two crests supported by a short median septum; posteriorly these all unite to form a single apophysis grooved in the middle and uniting with the inner surface of the deltidium. The brachial valve has a prominent bifid cardinal process, and a pair of small protuberances representing the crural plates; from the base of the cardinal process extends a median

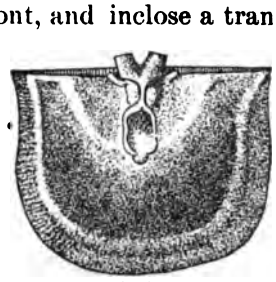
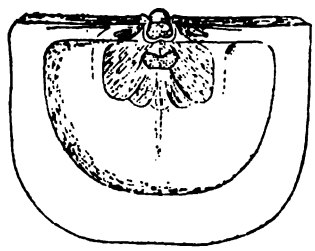


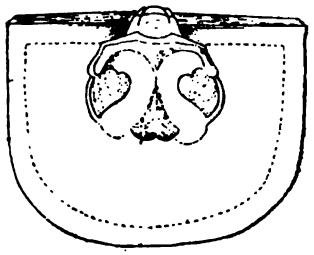
FIG. 270.—Brachial valve of *Douvillina Dutertrii*. After EHLERT.

ridge which bifurcates anteriorly inclosing a cavity for the insertion of the anterior adductors. (Type, *D. Dutertrii*, Murchison (sp.). Devonian.)

Cadomella, Munier-Chalmas. 1887.

Shell nearly flat or gently concavo-convex; hinge-line long, straight; beak of pedicle-valve scarcely prominent; cardinal areas linear; deltidium narrow. On the interior the pedicle-valve bears divergent teeth between which lies an apophysis, serving as a base of attachment for the accessory diductors. The principal diductor scars are flabellate, but do not extend beyond the umbonal region. In the brachial valve is a stout cardinal process, grooved upon its upper surface near the lateral margins. Socket-walls greatly elevated and continued into curved crural apophyses which have a tendency to become free toward their





Cadomella Moorii.

FIG. 271.—Interior of pedicle-valve. FIG. 272.—Interior of brachial valve. (MUNIER-CHALMAS.)

extremities. There is a median septum which, at its anterior end, at the center of the valve, is strongly elevated and bilobed. The four adductor impressions united into two cordate scars whose outer margins are strongly thickened.

Type, *Cadomella Moorii*, Davidson (Lias).

Strophonella, Hall. 1879.

(Plate 15, Figs. 5–11.)

Shells semicircular or semielliptical, concavo-convex, resupinate, the pedicle-valve concave and the brachial valve convex. Area of pedicle-valve striated, solid, with or without a central deltidial scar, or rarely a partial foramen, with similar features on the narrow area of the brachial valve; inner margins of the cardinal areas of each valve crenulate, and from beneath

the center of the ventral area there is often a strong process (frequently bilobed) which extends beyond the cardinal line. Muscular area of the pedicle-valve strongly marked, and limited by a prominent border. Brachial valve with a narrow hinge-area transversely or longitudinally striate, or both, and marked in the center by a deltidial scar. Cardinal process double, each division notched or bidentate at the extremity; muscular areas quadrangular.

Type, *Strophonella fasciata*, Hall.

Distribution. Upper Silurian – Upper Devonian.

Subgenus **Amphistrophia**, Hall. 1892.

(Plate 15, Figs. 12–14.)

Shells with convex deltidium and very short row of cardinal denticulations. In the pedicle-valve the muscular area is not inclosed; in the brachial valve muscular markings extremely faint.

(Type, *A. striata*, Hall (sp.). Upper Silurian.)

Strophomena, Rafinesque (de Blainville). 1825.

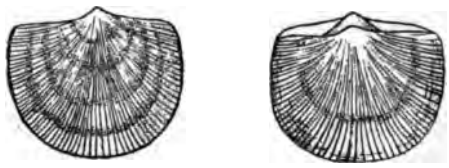
(Plate 14, Figs. 1–7.)

Synonyms: (?) *Strophomenes*, Rafinesque, 1820, 1831; Defrance, 1824.

Shells transversely subsemicircular or semielliptical; greatest width along the hinge-line. Surface concavo-convex and covered with fine radiating striæ which are equal or alternate in size. The pedicle-valve is slightly convex about the umbo, but becomes rapidly concave toward the middle with the apex perforated, except in old age. The cardinal area is conspicuous and nearly vertical, and the delthyrium closed by a convex plate or deltidium. Teeth widely divergent and supported by plates which are produced into elevated ridges nearly surrounding the muscular area. The latter is relatively short, subcircular in outline, deeply excavated and divided medially by a more or less distinctly defined longitudinal ridge which is often continued over the pallial region.

The brachial valve is concave at the umbo, becoming strongly convex with growth; it has much the narrower cardinal area, and the delthyrium is rudimentary or incomplete. Dental sockets

deep, and continued as narrow grooves or indentations across the cardinal area. The crural plates are extended laterally with a slight curve, but are not supported by septa: at their inner margins they unite to form a callosity, upon which rests the short, bilobed cardinal process, which scarcely extends beyond the hinge-line. The muscular surface of this process is cordate in outline and is placed at a low angle to the plane of the area. A low median ridge extends forward from the hinge-



FIGS. 273, 274.—*Strophomena rugosa*. After DE BLAINVILLE.

plate separating two large adductor scars, in front of which are two narrow elongate impressions. Vascular and ovarian markings frequently well defined. Shell-substance fibrous, strongly punctate.

Type, *Strophomena rugosa* Rafinesque (de Blainville), 1825,= *Leptæna planumbona*, Hall, 1847, as recognized by KING and other authors.

Distribution, Lower —(?) Upper Silurian.

Orthothetes, Fischer de Waldheim. 1830.

(Plate 14, Figs. 8–16.)

Shells plano-convex or biconvex, sometimes becoming concavo-convex with age. Brachial valve usually the deeper in the pallial region; pedicle-valve highest about the umbo, which is sometimes much extended, and often shows a pronounced tendency to irregular growth. Surface covered with slender, subequal radii, which are crenulated by sharp concentric striæ. Hinge-line long, equaling, and often greater than the width of the shell; in some species frequently showing a tendency to auriculation at the extremities. Pedicle-valve with the cardinal area prominently developed; the delthyrium covered by a thick, more or less convex deltidium, which is rarely if ever perforated at maturity. On the interior the teeth are moderately large, sometimes thickened, but not supported by dental plates. The

muscular area is marked by flabelliform cardinal scars, inclosing a small adductor impression.

In the brachial valve the cardinal area is narrow, the deltidial covering small and emarginate at the center. The cardinal process is united to the crural plates, the whole forming a vertical subcrescentic process, most elevated centrally and notched or divided at its crest, making it bilobed or bidentate, as seen from its inner surface; on its outer or posterior face each apophysis is deeply grooved, giving the entire cardinal process, from this point of view, a distinctly quadrilobate appearance. The crural plates end more or less abruptly in elevated points, which undoubtedly mark the place of attachment of the crura. The bases of these plates are not produced around the muscular area. Muscular impression flabelliform, very much as in the other valve; divided medially by a low faint ridge. Shell-substance strongly punctate.

Type, *Orthothetes crenistria*, Phillips (sp.).

Distribution. Upper Silurian — Carboniferous.

Hipparionyx, Vanuxem. 1842.

(Plate 14, Figs. 17–20.)

Shell large, subhemispherical. In youth, the pedicle-valve is very slightly convex, but at maturity it is depressed, or concave, over the pallial region. The brachial valve is always very convex. Marginal outline of the valve subcircular. On the pedicle-valve the hinge-line is straight but short, the cardinal area low, and the beak retrorse. The delthyrium is broad, and covered by an imperforate convex deltidium. The teeth are moderately large and are supported by lamellæ which extend to the bottom of the umbonal cavity, and are produced into strong ridges entirely surrounding the muscular area. This area is very large and is composed of broad, flabellate diductors inclosing an elongate or cordate adductor impression. There is a low median septum in the umbonal cavity, separating the arms of the cardinal process of the opposite valve, but it is quite short, disappearing at the adductor scar, though sometimes reappearing in front of it.

In the brachial valve there is no cardinal area. The cardinal process has essentially the same structure as in ORTHOTHETES and DERBYA, but is very high, its two branches completely traversing

the umbonal cavity of the opposite valve; it is supported by a short, median septum, and laterally by strong crural plates which extend for a short distance along the margins of the muscular impressions; these are usually quite faint and undefined, occupying a much smaller area than in the pedicle-valve, and leaving arborescent markings as in some species of STROPHEODONTA. On the interior of both valves the margin is sharply pectinated, or crenulated, the crenulations on the brachial valve extending to the base of the cardinal process, and in the pedicle-valve extending for a considerable distance on the cardinal area. Surface of both valves covered with fine sharp radiating striæ. Shell substance punctate.

Type, *Hipparionyx proximus*, Vanuxem.

Distribution. Lower Devonian (Oriskany sandstone; but a single species is known).

Kayserella, Hall. 1892.

Shell subsemicircular; hinge-line nearly equaling in length the greatest width of the shell; convexity normal. Pedicle-valve more convex than the brachial; area moderately high; delthyrium covered by a convex plate. Brachial valve slightly convex; area narrow; chilidium well developed. In the interior, a large triangular median septum extends almost to the bottom of the opposite

FIGS. 275, 276, 277.— *Kayserella lepida*. After KAYSER.

valve. Surface with a slight median ridge and furrow on pedicle and brachial valves respectively; covered with sharp plications, increasing by intercalation near the margin. Shell substance punctate.

Type, *Kayserella lepida*, Schnur (sp.).

Distribution. Middle Devonian (Eifel; but a single species is known).

Derbya, Waagen. 1884.

(Plate 17, Figs. 1-9.)

General character of the shell as in ORTHOTHETES. The external form is more variable, being usually plano-convex, sometimes concavo-convex, the pedicle-valve often the more elevated and sub-

pyramidal, becoming irregular in its growth toward the apex. The interior of the pedicle-valve bears a high median septum, extending longitudinally through the center of the muscular area, which is from one-third to two-thirds the length of the valve: near the apex of the umbonal cavity it unites with the dental plates forming a small triangular chamber beneath the deltidium. In old shells this cavity is often filled by testaceous secretion. The dental plates do not extend to the bottom of the rostral cavity except near the apex.

Brachial valve broad and regularly convex, or sometimes with an undefined median depression, and showing a tendency to auriculation at the cardinal extremities. Cardinal area linear; the crural plates are abruptly elevated, and unite to form a strong, erect cardinal process, which is distinctly bilobed at the summit; each lobe being slightly notched at the summit and distinctly grooved along the posterior face, these grooves uniting in a wider one at the posterior base of the process. Midway in their length these crural plates are marked by a transverse ridge which terminates on their anterior face in points for the attachment of the crura; on the inside of the dental sockets there is a distinct, sometimes strongly defined ridge, extending along the lateral margin of the broad flabelliform muscular area, and gradually becoming obsolete. There is also a slight median ridge which becomes obsolete below the middle of the muscular area. Surface marked by strong, sharply elevated radii, which alternate with finer ones, all being crenulated, and the intermediate space cancellated by fine concentric striæ.

Type, *Derbya regularis*, Waagen.

Distribution. Carboniferous.

Meekella, White and St. John. 1868.

(Plate 17, Figs. 10–13.)

Shell robust, biconvex, often subpyramidal. Hinge-line straight and shorter than the greatest width of the shell. On the pedicle-valve the cardinal area is often greatly elevated and distorted; the delthyrium is covered; the convex portion of the deltidium being much narrower than the space between the dental ridges. In the interior the teeth are prominent and supported by septiform dental lamellæ which reach the bottom of the umbonal

cavity and extend forward for one-third or one-half the length of the shell. The brachial valve has a full, gibbous umbo, and a rudimentary or linear cardinal area. On the interior are two divergent lamellæ or crural plates, which are extended forward for more than one-third the length of the valve, supporting a high, erect cardinal process, which sometimes reaches almost to the apex of the umbonal cavity in the opposite valve. This process is a somewhat curved, thin, crescentic plate, bearing on its summit two slender median apophyses, below which are two stouter lateral projections having the form of extended, rounded lobes, which form the bases of the crura. Surface of the valves marked with coarse costæ, which, with the interspaces, are covered by fine radiating, often plumose, striæ. Shell-substance fibrous, punctate.

Type, *Meekella striatocostata*, Cox (sp.).

Distribution. Upper Carboniferous.

Streptorhynchus, King. 1850.

(Plate 17, Figs. 14–18.)

Shells somewhat trihedral and subpyramidal, with base convex; hinge-line shorter than the greatest width of the valves. Pedicle valve having the beak acute and often incurved and distorted. Cardinal area high, somewhat incurved; delthyrium covered by a broad imperforate, depressed-convex deltidium. The interior of the valve with low dental ridges terminating in teeth of moderate size; these ridges are not septiform and do not continue to the bottom of the umbonal cavity; there is no median septum; muscular scars strong and flabelliform.

In the brachial valve the cardinal area is linear, the crural plates are vertical and abruptly elevated on their anterior edges, forming points of attachment for the crura; these unite to form a subcrescentic plate, from the center of which arises a broad, erect, cardinal process, which is deeply divided into two lobes, each of which is faintly grooved at its summit and on the posterior face; muscular area small, divided medially by a low ridge. Exterior surface covered by fine radiating striæ.

Type, *Streptorhynchus pelargonatus*, Schlotheim (sp.).

Distribution. Carboniferous (?) — Permian.

Triplecia, Hall. 1858.

(Plate 18, Figs. 1–15.)

Synonym; *Dicraniscus*, *Meek*, 1872.

Shell trilobate, transverse, unequally biconvex. Hinge-line straight and quite short. Pedicle-valve shallow, convex about the beak, but depressed anteriorly by a broad and deep median sinus; cardinal area low, erect and well defined; delthyrium covered by a narrow, convex plate, with a circular foramen at the apex. In the interior the teeth are well developed and supported by short dental lamellæ longitudinally dividing the umbonal cavity near its apex. Muscular area small, comprising two lateral scars, separated by a longer central adductor impression. The brachial-valve is very convex, and bears a strong median fold. The cardinal area is very narrow and the beak closely incurved. In the interior is a long, erect and bifurcate cardinal process, the distal extremity of each branch bearing a single deep groove. This process is supported on a subrostral callosity, which also bears two short spiniform crural points at its base. Shell-substance fibrous, impunctate (?). Surface with obscure concentric growth-lines, and fine radiating striæ on the inner laminæ; in rare instances there are radiating lines on the exterior.

Type, *Triplecia extans*, Emmons, (sp.)

Distribution. Lower — upper Silurian.

Mimulus, Barrande. 1879.

(Plate 18, Figs. 16–19.)

Contour trilobate as in TRIPLECIA median fold on the pedicle-valve in the typical species. Shells sometimes bilaterally unsymmetrical. Cardinal area of the pedicle-valve smooth, with but little if any external evidence of deltidium. Teeth small, not supported by dental lamellæ. Brachial valve with an erect, deeply bifurcated cardinal process.

Type, *Mimulus perversus*, Barrande.

Distribution. Upper Silurian.

Streptis, Davidson. 1881.

(Plate 18, Figs. 20–22.)

Shells biconvex, bilaterally unsymmetrical; divided medially by a sinus. Pedicle-valve with a well-defined cardinal area and foramen. Teeth small, supported by short dental plates. Brachial valve with an erect, probably bifurcated cardinal

process. External surface covered with lamellar expansions at the concentric growth-lines.

Type, *Streptis Grayi*, Davidson.

Distribution. Upper Silurian (England and Bohemia).

Plectambonites, Pander. 1830.

(Plate 19, Figs. 1–7.)

Shells usually small, normally concavo-convex. Surface covered with very fine striæ, often alternating in size. Hinge-line making the greatest width of the shell, the extremities often subauriculate. Cardinal area narrow in both valves, sometimes obscurely crenulated on the margins. Pedicle-valve with a moderately broad delthyrium which is partially closed by a convex plate, but mostly occupied by the cardinal process of the opposite valve. Apical foramen sometimes retained. Teeth prominent and supported by thickened plates, which are continued in broad outward curves for more than half the length of the valve, returning and uniting in the unbonal cavity, thus limiting two linguiform muscular scars, inclosing a more or less clearly defined adductor impression.

In the brachial valve, the dental sockets are deep, and often appear to transect the cardinal area. The cardinal process is simple and erect, but by its coalescence with the short prominent crural plates, the posterior face appears trilobate. The crural plates end abrutly as in ORTHOTHETES; becoming thickened at about the middle of their length, giving origin to two low ridges or septa, which at first approach each other, and thence continue forward with a slight divergence, thus forming the inner boundaries of two elongate muscular scars, which are less sharply defined on their outer margins. The muscular area is rendered quadripartite by two short transverse or oblique posterior furrows. Vascular impressions radial, sometimes digitate Shell-substance fibrous, sparsely punctate.

Type, *Plectambonites planissima*, Pander.

Distribution. Lower — Upper Silurian.

Christiania, Hall. 1892.

(Plate 19, Figs. 8–13.)

Shells usually longitudinally elongated, sometimes semielliptical in outline; normally concavo-convex. Surface smooth or covered with fine radiating lines which are crossed by stronger,

rather regular concentric plications. In the pedicle-valve the cardinal area is moderately high and the delthyrium in its normal condition probably closed by a convex plate. The teeth are very divergent and from their bases extend the elevated margins of two linguiform muscular scars, traversing the shell for almost its entire length. These scars, which may be regarded as the diductors, inclose two, much shorter, but still elongate adductors. In the brachial valve the cardinal process is bipartite on its anterior face, each of the lobes being grooved behind; the crural plates are very long and divergent, terminating in elevated extremities or crura. The lower moiety of these plates is produced on each side of a strongly elevated muscular ridge, curving slightly inward on the sides, then outward on approaching the anterior margin of the valve, each branch recurving and passing backward, parallel to the median axis, as far as the base of the cardinal process. The symmetrical spaces thus limited are each divided transversely at about one-third their length from the hinge-line, by a somewhat lower vertical ridge. The four areas thus inclosed represent the posterior and anterior scars of the adductor muscles. Between the inner muscular walls, in the median line, is a low, rounded longitudinal ridge.

Type, *Christiana subquadrata*, Hall.

Distribution. Lower Silurian (?)—Devonian.

Leptænisca, Beecher. 1890.

(Plate 19, Figs. 14–21.)

Shell concavo-convex, attached to foreign objects by calcareous cementation of the pedicle-valve. Brachial valve concave; interior with a broad, more or less defined, spiral impression on each side of the median line, making a single volution. Adductor impressions small. Cardinal area narrow, bearing in the center two prominent bilobed, cardinal processes, separated to admit the vertical septum in the opposite beak. Pedicle-valve convex, area elongate triangular, fissure covered with a pedicle-sheath. Cardinal muscular scar supported on, or limited by a vertical septum, on each side of which, in the anterior half, is a small adductor scar. Shell structure punctate.

Type, *Leptænisca concava*, Hall (sp.).

Distribution. Lower Devonian.

Davidsonia, Bouchard. 1849.

(Plate 19, Figs. 22-24.)

Shell thick, plano-convex, transversely oval. Surface smooth or with concentric growth-lines, fixed to foreign bodies by the umbonal portion and the greater part of the surface of the pedicle-valve. Hinge-line straight and quite narrow. On the pedicle-valve the delthyrium is covered by a convex imperforate plate; the teeth are large, the dental lamellæ obscure. The muscular area is comparatively small, lying in the umbonal region, and is subdivided into two cardinal scars inclosing an elongate adductor. In the pallial region there is a low median septum which separates two conical callosities of the shell, having their apices directed toward the opposite valve. These protuberances are grooved by a spiral furrow which makes five or six volutions, and are frequently crossed by vascular sinuses.

In the brachial valve the chilidium is convex, embracing the base of the posterior face of the cardinal apophysis. The cardinal process has very much the same structure as in PLECTAMBONITES; consisting of a central, short, erect process, to which the crural plates are attached, giving it a trilobate appearance. These plates terminate abruptly at their distal extremities. The muscular area is quadruplicate and of about the same size as in the opposite valve. Two conical depressions in the pallial region correspond to the protuberances of the opposite valve. Shell-substance punctate (?).

Type, *Davidsonia Verneuili*, Bouchard.

Distribution. Middle Devonian (Europe).

Chonetes, Fischer de Waldheim. 1837.

(Plate 20, Figs. 1-14.)

Shells semicircular or transverse, usually normally concavo-convex, sometimes plano-convex. Hinge-line straight, making the greatest diameter of the shell. Pedicle-valve with a narrow concave or flat cardinal area; the delthyrium more or less completely covered by a convex imperforate deltidium. The upper margin of the area bears a single row of hollow vertical or divergent spines, which increase in length toward the cardinal angles; these spines are the prolongations of tubes which

penetrate obliquely the substance of the shell along the cardinal line, converging toward the apex of the valve till they reach the surface, where they turn at an abrupt angle upward and outward and are thence continued as hollow spines. Cardinal teeth strong. A low median ridge, slightly thickened at its posterior extremity, where it is sometimes coalesced with the deltidium, extends forward, dividing the muscular area. The muscular scars are usually faint, and consist of flabelliform diductors which partially inclose elongate median adductors.

In the brachial valve the cardinal area is very narrow, and without spines. The deltidium is partially developed, resting against the cardinal apophysis. This process is very similar in character to that in PLECTAMBONITES, consisting of a median portion, coalescing at its base with the elongate crural plates. On its posterior face it is divided by a narrow median furrow and two broader lateral grooves, giving it a quadrilobate appearance. The crural plates are slightly divergent from the hinge-line, bounding narrow, elongate sockets. A median ridge separates the quadruplicate muscular impression and from between the anterior and posterior members of this impression originate two linear brachial ridges, which extend outward, recurving toward the median line at about the middle of the valve, making a reniform curve. Interior surface of both valves strongly papillose in the pallial region.

External surface usually covered with radiating striæ, rarely smooth or concentrically rugose. Shell-substance fibrous-punctate.

Type, *Chonetes striatella*, Dalman (sp.).

Distribution. Upper Silurian—Carboniferous.

Subgenus **Anoplia**, Hall. 1892.

(Plate 20, Figs. 15–19.)

Shells small with smooth or squamous exterior. No external evidence of cardinal spines, though the spine-tubes exist in one or more pairs in the substance of the pedicle-valve. On the interior a median septum in the pedicle-valve. Cardinal process and muscular impressions of the brachial valve as in CHONETES.

(Type, *A. nucleata*, Hall (sp.). Oriskany sandstone = Lower Devonian.)

(?) Subgenus CHONETINA, Krotow. 1888.

These shells differ from CHONETES in their very convex pedicle-valve having a profound sinus; the brachial valve, very concave, follows the curvature of the larger: in the interior of the brachial valve are tubercles arranged in radiating series which unite to form high, compact lamellæ, extending from the beak to the anterior margin; two of these, more prominent than the rest, limit the surface occupied by the sinus of the larger valve.

(Type, *C. Artiensis*, Krotow. Permian.)

Subgenus **Chonostrophia**, Hall. 1892.

(Plate 20, Figs. 20–24.)

Shell reversed concavo-convex, the pedicle-valve being slightly convex about the umbo, but becoming broadly concave over the pallial region. Outline and contour strophomenoid; valves extremely tenuous and compressed; surface covered with fine alternating or fasciculate striæ. In the pedicle-valve the upper margin of the cardinal area bears a row of hollow spines of the same structure and arrangement as in CHONETES. The delthyrium is narrow and appears to be more or less completely closed. The teeth are quite strong and rest upon the bottom of the valve; between them arises a low median septum which may be traced from one-third to one-half the length of the valve, dividing a subcordate muscular area, the outer margins of which are distinctly elevated.

In the brachial valve the crural plates are united to form a bilobed cardinal process. The outer face of this process has not been observed; on the inner surface it is not continued into a median septum but ends abruptly. Muscular area very faintly defined in the type-species. Internal surface over the pallial region finely papillose. Shell-substance fibrous, punctate.

(Type, *C. reversa*, Whitfield (sp.). Lower Devonian.)

Subgenus **Chonetella**, Waagen. 1884.

Shell small, normally concavo-convex. Surface rounded, with radial striæ; cardinal area narrow; deltidium, cardinal spines and teeth as in CHONETES. In the pedicle-valve the adductor impres-

sions are elongate, and are partially inclosed by the larger diductors. The brachial valve has a small trilobed cardinal process, which is continued into a low medial septum. The muscular area is quadripartite and very distinct. The brachial ridges are sharply defined and appear to originate near the outer extremities of the posterior adductors, making a broad outward, and a more abrupt inward curve, completing one volution. Surface in the pallial region strongly papillose.

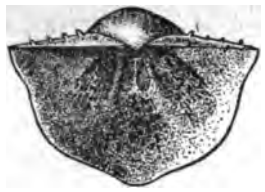


FIG. 278.—*Chonetella nasuta*. After WAAGEN.

(Type, *Chonetella nasuta*, Waagen. Upper Carboniferous.)

Chonopectus, Hall. 1892.

(Plate 20, Figs. 25–27.)

Shells normally concavo-convex; cardinal margin of pedicle-valve with a row of spines. Beak of pedicle-valve compressed or flattened from attachment in early growth. Internal markings obscure. External surface reticulated by a double, oblique series of concentric lines covering exceedingly fine radiated striæ.

Type, *Chonopectus Fischeri*, Norwood and Pratten (sp.).

Distribution. Lower Carboniferous. But a single species is known.

Strophalosia, King. 1844.

(Plate 21, Figs. 1–11.)

Shells productoid in general form; a cicatrix, usually apparent on the umbo of the pedicle-valve, indicates that they were attached to foreign bodies by the substance of the shell. Both valves have a well-defined area and covered delthyrium, these features being much the more conspicuous in the pedicle-valve. In this valve the teeth are prominent, but not supported by lamellæ; the muscular arrangement is the same as in PRODUCTUS, though the diductor impressions are relatively larger and more elongate, extending beyond the limits of the central adductors. In the brachial valve the cardinal process is erect, bifid on its anterior, and quadrifid on its posterior face. It is supported on each side by short arched crural plates, and is continued into a median septum which extends for half the length of the valve.

Muscular impressions small, quadruple, not dendritic, the interior pair being sharply raised. The brachial ridges originate from between the adductor scars, curving gently outward, recurving, at first gradually and then abruptly, to their anterior limit; thence turning suddenly backward, and again horizontally inward, meeting the median septum near its anterior extremity.

Surface of the pedicle-valve covered with spines, which near the beak are often curved backward, embracing some external object. In some species all the spines of the valve have evidently been at least of accessory importance in effecting

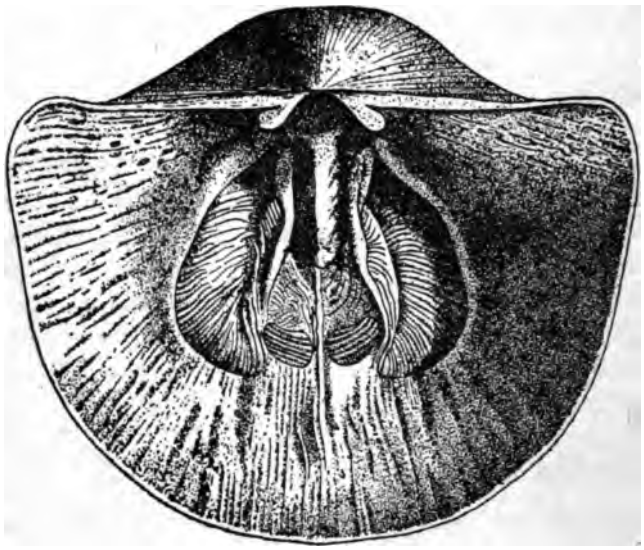


FIG. 279.—*Daviesiella Llangollensis.* (DAVIDSON.)

attachment of the shell. The surface of the brachial valve may be either spinous, lamellose or smooth.

Type, *Strophalosia Goldfussi*, Münster.

Distribution. Middle Devonian–Permian.

Daviesiella, Waagen. 1884.

Shells large, with cardinal area and teeth well developed. External surface covered with fine radiating striæ and devoid of spines.

Type, *Daviesiella Llangollensis*, Davidson (sp).

Distribution. Coal measures.

Aulosteges, von Helmersen. 1847.

(Plate 21, Figs. 12–14.)

Shell productiform in general aspect, somewhat depressed, not attached. On the pedicle-valve the cardinal area is prominently developed, frequently somewhat distorted; the delthyrium is closed by a convex deltidium which is covered with little tubercles or spinules. Cardinal teeth rudimentary or absent. In the brachial valve the cardinal area is linear, the cardinal process large, quadrifid; its base being surrounded by a strong deltidial callosity. Brachial ridges extending nearly to the anterior margin and abruptly incurving. Otherwise the interior impressions are as in PRODUCTUS. Surface of both valves thickly set with spines.

Type, *Aulosteges Wangenheimi*, De Verneuil.

Distribution. Permian.

Productus, Sowerby. 1812.

(Plate 22, Figs. 1–12.)

Shell free, concavo-convex, the valves usually produced anteriorly; outline semicircular, sometimes transversely elongate. Pedicle-valve convex, sometimes geniculated, occasionally with a median sinus. Cardinal extremities frequently auriculate. Umbo inflated, with apex incurved. Hinge-line straight, cardinal area and teeth absent or rudimentary. External surface usually with more or less prominent radiating ribs which are crossed, especially in the umbonal region, by concentric lines of wrinkles; rarely smooth or finely striated, often studded with spines varying in size and abundance. These spines are frequently scattered irregularly over the surface, generally strongest and disposed with greatest regularity upon the cardinal extremities, and sometimes occurring only in this region. They are hollow and appear to have communicated with the interior cavity of the shell. On the interior of the valve is a narrow median ridge, separating the two dendritic impressions of the adductor muscles; outside and in front of these are two broadly flabellate, longitudinally striated scars of the diductor muscles. In the pallial region are sometimes found traces of spiral cavities, which were occupied by the fleshy arms.

The brachial valve is operculiform, more or less concave or almost flat over the visceral area. Cardinal area, sockets and crural plates absent or rudimentary; cardinal process strong, curved or erect, extending far above the hinge-line; its inner face is divided into two lobes by a longitudinal furrow, and each of these parts is deeply divided at its extremity, giving the process in this aspect a quadrilobed appearance. As viewed from the posterior or outer face it is strongly trilobed, the inner members of the lateral lobes coalescing to form a very prominent apophysis. The process is continued over the interior of the shell as a longitudinal septum, dividing the impressions of the adductor muscles. The latter are strongly dendritic and rarely divisible into anterior and posterior elements. The brachial ridges take their origin from near the post-lateral margins and nearly inclose a sub-circular, smooth or granulose area. The internal surface of this valve is strongly pustulose, and in the pallial region frequently spinous. Shell substance fibrous, strongly punctate.

Type, *Productus semireticulatus*, Martin (sp.).

Distribution. Devonian (?) — Permian.

Subgenus **Productella**, Hall. 1867.

(Plate 21, Figs. 15–24.)

Shells small, productoid. Surface spinous. Pedicle-valve with narrow cardinal area, deltidium and small teeth. Brachial valve with sockets and crural plates.

(Type, *P. subaculeatus*, Murchison (sp.). Devonian.)

Subgenus **Marginifera**, Waagen. 1884.

(Plate 22, Figs. 13–15.)

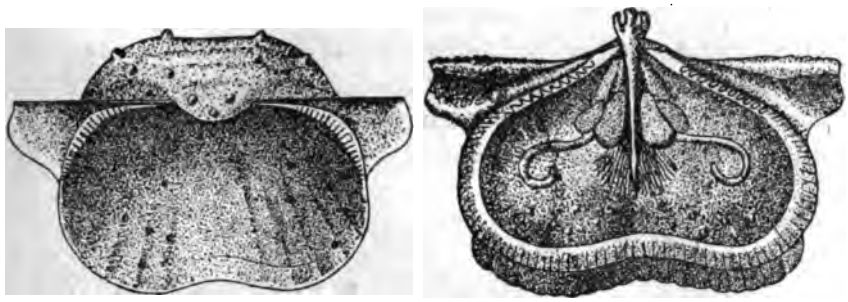
Externally like PRODUCTUS. On the interior of the pedicle-valve are prominent shelf-like ridges on either side of the beak, extending inward and crenulated on their margins. There are similar but vertical ridges on the interior of the brachial valve.

(Type, *Marginifera typica*, Waagen. Devonian (?) to Permian.)

Subgenus **Proboscidella**, Ehlert. 1887.

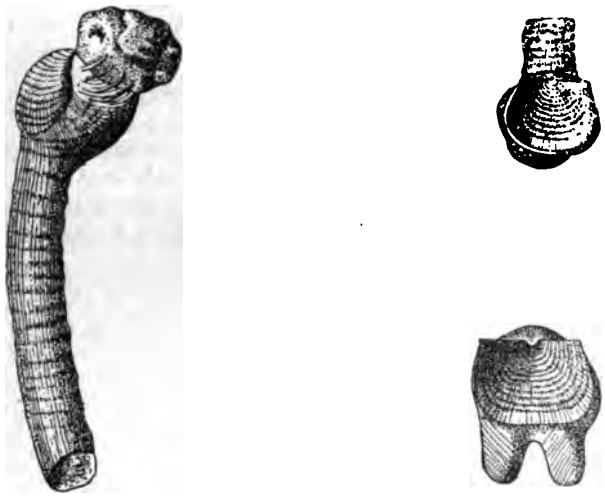
Valves very unequal; the brachial valve small, concave, operculiform; the pedicle-valve larger, convex, furnished with two lateral expansions which bend downward to meet the margins of

the brachial valve, and an anterior expansion which is produced forward into a long cylindrical tube, sometimes attaining twice the length of the shell; the suture appears on the dorsal side in the median line. Sometimes instead of a single tube there is a double enrollment resulting in two distinct tubes. The surface



FIGS. 280-281.— *Marginifera typica*, Waagen. After WAAGEN.

is ornamented by concentric plications, traversed by fine radiating ribs, which are flexuous and close together, the last plication, and the groove accompanying it, is sharper than the others and



FIGS. 282-284.—*Productus (Proboscidella) proboscideus*, de Verneuil. After DE KONINCK.

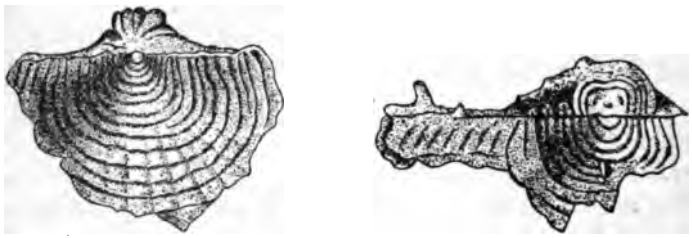
marks the separation of the pedicle-valve, properly speaking, from its lateral and anterior expansions upon which the concen-

tric markings are rare, faintly developed or wholly wanting, while the radiating striæ are regularly continued.

(Type, *P. proboscideus*, De Verneuil. Carboniferous.)

Subgenus **Etheridgina**, Œhlert. 1887.

Shells of very small size, nearly as broad as long, attached to foreign bodies by the spines of the pedicle-valve; cardinal line straight, nearly or quite equaling the greatest width of the shell; pallial outline semicircular; pedicle-valve with a small beak; surface ornamented by concentric flexuous plica-



FIGS. 285, 286.— *Productus (Etheridgina) complectens*, Etheridge. After ETHERIDGE.

tions, bearing a few scattered spines; cardinal process quadrifid.

(Type, *E. complectens*, Etheridge (sp.). Carboniferous.)

[NOTE.—The continuation of this present paper upon the Brachiopoda is already far advanced, and it is expected that it will be published in the Annual Report of the State Geologist for 1893. The second part will include the spire-bearing Genera, the Rhynchonelidæ, Pentameridæ and the Ferebratuloide.]

EXPLANATIONS OF PLATES.

PLATE 1.

Legend.
- p. Pedicle-groove.
- ps. Pedicle sheath.
- g. Umbonal scars.
- l. Lateral scars.
- k. Middle laterals.
- j. Anterior laterals.
- l. Outside laterals.
- x. Concrete laterals.
- h. Central scars.
- b. Parietal scar.
- cr. Crescent.
- i. Transmedian scars.
- d. Cardinal area.
- s. Median septum.
- s'. Lateral septa.
- sv. Vascular trunks.
- v. Vascular branches.
- cc. Cardinal callosities.
- pl. Platform.

LINGULA, BRUGUIÈRE.

Page 226.

LINGULA ANATINA, Lamarck.

Fig. 1. The interior of the pedicle-valve; showing the character of the muscular scars and septa as they appear when the muscular bands and the mantle are wholly removed. Natural size.

Fig. 2. Brachial valve of the same. Natural size.
Recent. *Philippine Islands.*

LINGULA ELDERI, Whitfield.

Figs. 3, 4. Copies of the lithographic figures given by Mr. WHITFIELD (Geol. Surv. Wisconsin, vol. iv, pl. 27, figs. 4, 5), of the interiors of the pedicle and brachial valves, respectively. Drawn from a cast which preserves the internal characters with remarkable completeness. × 2.
Trenton limestone. *Near Rochester, Minnesota.*

LINGULA PHILOMELA, Billings.

Fig. 5. A pedicle-valve (?), imperfect in the umbonal region; illustrating one extreme of outline attained by shells of this genus.
Trenton limestone. *Florenceville, Howard county, Iowa.*

LINGULA IOWENSIS, Owen.

Fig. 6. The interior of a brachial valve; showing the conspicuously developed median septum, the well-defined central scars (h), and the progressive laterals (x).
Galena limestone. *Fountain, Minnesota.*

LINGULA COVINGTONENSIS, Hall and Whitfield.

Fig. 7. The exterior of a pedicle-valve; showing the suborbicular outline.
Hudson River group. *Near Cincinnati, Ohio.*

LINGULA TÆNIOLA, Hall.

Fig. 8. The pedicle-valve; showing the peculiar surface ornamentation, crossed near the beak by concentric growth lines. × 1.5.
Clinton group. *Clinton, N. Y.*

LINGULA LAMELLATA, Hall.

Fig. 9. The exterior of the pedicle-valve.
Niagara group. *Lockport, N. Y.*

GLOSSINA, PHILLIPS.

Page 230.

GLOSSINA ACUMINATA, Conrad.

Fig. 10. A pedicle-valve from which most of the substance of the shell has been exfoliated, presenting a cast of the internal surface, which retains the impressions of the fine radiating, and coarser, more distinct, concentric lines. The thickness of the shell-substance and the undulating character of its laminæ is shown on the marginal portion of the figure, but no traces of muscular impressions are discernible. × 2.

Fig. 11. A brachial valve of the same species, from which the shell is partially exfoliated. × 2.
Calciferous sandstone. *Saratoga, N. Y.*

DIGNOMIA, HALL.

Page 230.

DIGNOMIA ALVEATA, Hall.

Fig. 12. A cast of a brachial valve, showing the long, sharp median septum and the fainter diverging lateral septa. Natural size.
Hamilton shales. *Fultonham, N. Y.*

Fig. 13. A portion of the interior of a large pedicle-valve (?), with a shorter and broader median septum and distinct lateral septa. Natural size.
Hamilton shales. *Canandaigua Lake, N. Y.*

BARROISELLA.

Page 230.

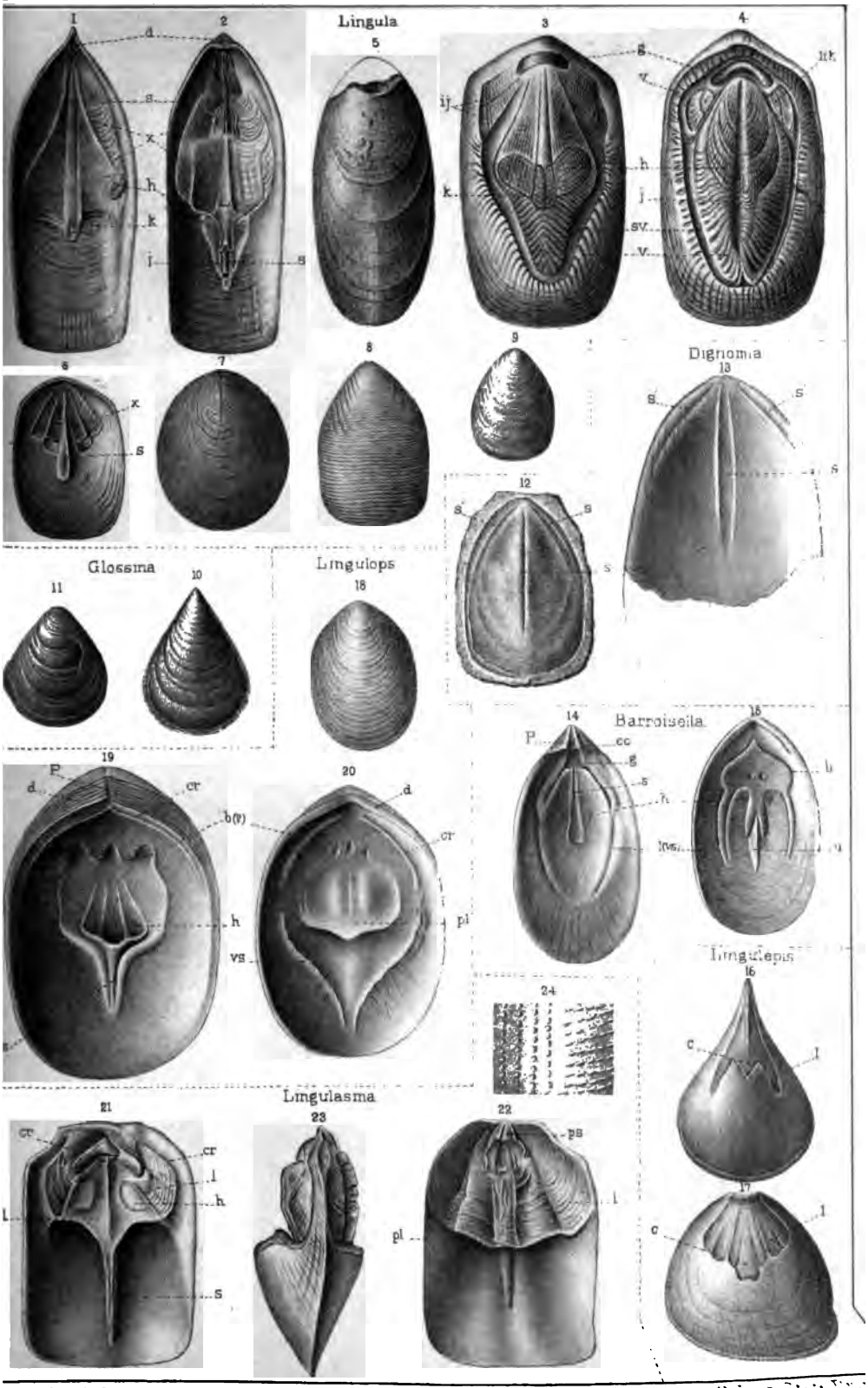
BARROISELLA SUBSPATULATA, Meek and Worthen.

Fig. 14. The interior of a pedicle-valve, showing the cardinal area, muscular and other markings. × 3.

Fig. 15. The interior of a brachial valve, with characteristic features. × 3.
Black slate (Genesee slate). *White River, near Rockford, Indiana.*

BRACHIOPODA.

Generic Illustrations.



LINGULEPIS, Hall.

Page 231.

Lingulepis pinniformis, Owen.

Fig. 16. An internal cast of a pedicle-valve; showing the faint median septum and the elongate muscular scar, with its lateral and central divisions. × 2.

Fig. 17. An internal cast of the brachial valve in which the muscular impression is flabellate, the central and lateral scars being quite distinct, the latter somewhat bilobed. × 2.

Potsdam Sandstone. *Falls of the St. Croix, Minnesota.*

LINGULOPS, Hall.

Page 233.

Lingulops Whitfieldi, Hall.

Fig. 18. The exterior of a pedicle-valve. × 6.

Fig. 19. The interior of a pedicle-valve; the original specimen. The figure has been drawn from a gutta-percha impression of an internal cast, and shows the compound cardinal area, the inner portion of which is concentrically striated; the crescent (cr); the scalloped parietal scar and median muscular scars; the narrow longitudinal septum flanked by broad, rounded ridges continued from the visceral region. No traces of vascular impressions are visible on the specimen. × 12.

Fig. 20. The interior of the brachial valve, drawn from a gutta-percha impression; showing the double cardinal area, a faint pedicle-depression, the crescent (cr), the parietal (?) scars, the platform, and the vascular sinuses with their outer ramifications. × 10.

Hudson River group. *Maquoketa Creek, 12 miles north-west of Dubuque, Iowa.*

LINGULASMA, Ulrich.

Page 235.

Lingulasma Schuchertı, Ulrich.

Fig. 21. The interior of a brachial valve; showing the character of the muscular impressions, the platform and the very strong septum. Drawn from a gutta-percha impression of an internal cast. Natural size.

Fig. 22. The interior of the pedicle-valve; showing the pedicle-sheath (ps), the indistinctly defined muscular impressions, the low platform and inconspicuous septum. This drawing is also made from a gutta-percha impression. Natural size.

Fig. 23. Profile view of an internal cast; showing the relative thickness of the platforms on the two valves.

Fig. 24. An enlargement of the surface ornamentation. The tubercles are sharply defined, and round on the median portions of the shell, but become elongated and less distinct toward the lateral margins. × 5.

Hudson River group. *Wilmington, Illinois.*

PLATE 2.

Legend.

a. Deltidium.
b. Deltidial slope.
c. Deltidial ridges.
cd. Cardinal area.
cr. Crescent.
d. Areal borders.
h. Cardinal buttress.
i. Umbonal chambers.
j. Platform.
k. Platform-vaults.
m. Median scars.
n. Anterior scars.
o. Lateral scars.
q. Crown of crescent.
r. Side of crescent.

DINOBOLUS, HALL.

Page 237.

DINOBOLUS CONRADI, Hall.

Fig. 1. An internal cast of a brachial valve, indicating very distinctly the muscular impressions and the minute platform-vaults.
Niagara limestone. *Grafton, Wisconsin.*

Fig. 2. The interior of a pedicle-valve; drawn from a gutta-percha impression taken from the specimen represented in fig. 3.

Fig. 3. An internal cast of the pedicle-valve; showing the filling of the chambers beneath the platform.

Fig. 4. The interior of a pedicle-valve, having the cardinal surface extremely developed. From a gutta-percha impression of a natural cast.
Niagara limestone. *Near LeClaire, Iowa.*

MONOMERELLA, BILLINGS.

Page 238.

MONOMERELLA PRISCA, Billings.

Fig. 5. An internal cast of a pedicle-valve, in which the umbonal chambers have their usual length. The crescent and lateral scars of the platform are unusually distinct.

Fig. 6. An internal cast of a brachial valve: showing the characteristic markings of the shell.
Niagara limestone. *Hawthorne, Illinois.*

RHINOBOLUS, HALL.

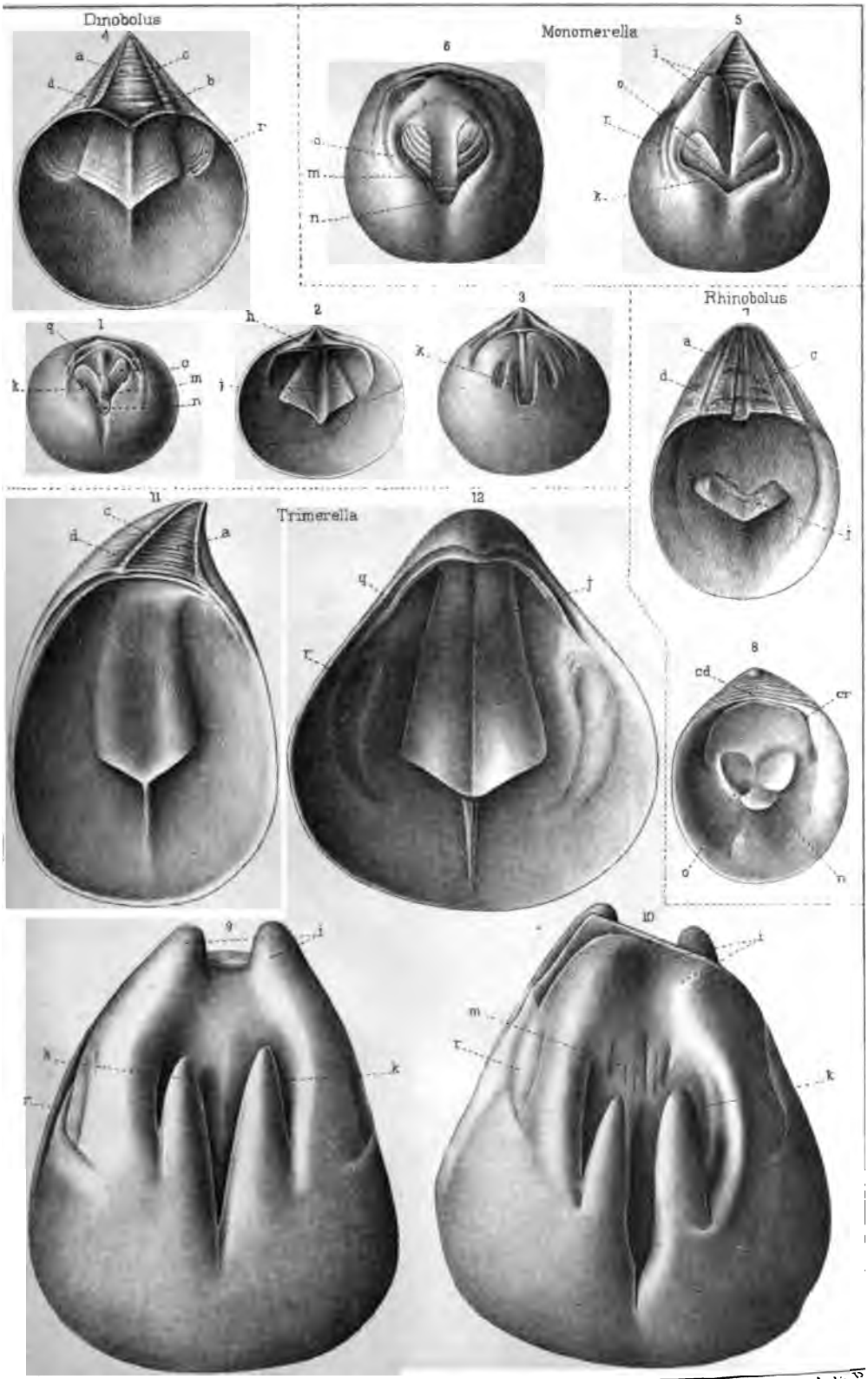
Page 239.

RHINOBOLUS GALTENSIS, Billings.

Fig. 7. The interior of a pedicle-valve; showing the narrow median, and broad lateral divisions of the cardinal surface, and the small, imperfectly developed platform. The drawing is made from a gutta-percha impression of a mold of the interior, the specimen being that originally taken as the type of the genus.
Guelph limestone. *Galt, Ontario.*

BRACHIOPODA.

Generic Illustrations.



Philip Ast lith

James E. Lee, Chicago, P

Fig. 8. The interior of a brachial valve; drawn from the specimens figured by WHITEAVES on plate 8, fig. 3, Palæozoic Fossils, vol. iii, pt. 1. Guelph limestone. *Hespeler or Durham, Ontario.*

TRIMERELLA, BILLINGS.

Page 236

TRIMERELLA GRANDIS, Billings.

Fig. 9. An internal cast, viewed from the brachial side; showing the low umbonal chambers, the length of the platform-vaults and the lateral scars of the crescent.

Fig. 10. The reverse of the same specimen; showing the much greater prominence of the umbonal chambers in this valve. The anterior margin and casts of the vaults have been slightly restored in the drawings. Niagara group. *Near Sinking Spring, Ohio.*

TRIMERELLA OHIOENSIS, Meek.

Fig. 11. A small pedicle-valve; showing a distortion of the umbo which extends to the posterior portion of the platform. The drawing is made from a gutta-percha impression, and the shell is somewhat restored in the umbonal region.
Niagara group. *Port Byron, Illinois.*

Fig. 12. A brachial valve; showing the incurvature of the beak, the subumbonal ridge merging into the crescent, the broad lateral scars of the crescent, the long relatively narrow platform with its medially depressed surface, and the strong anterior septum. Drawn from a gutta-percha impression of a natural cast.
Niagara group. *Rising Sun, Ohio.*

PLATE 3.

Legend.
- l. Laterals.
- c (h). Centrals.
- sc. Subcardinals or post-medians.
- cr. Crescent.
- e. Externals.
- x. Composite posteriors.
- P. Pedicle-groove.
- F. Foramen.
- f. Foraminal pits.
- s. Septum (median).
- s'. Septum (lateral).
- o. Vascular trunks (oviducts).
- d'. Subapical area.
- cb. Cardinal bosses.
- fc. Foraminal callosity.

LINGULELLA, SALTER.

Page 232.

LINGULELLA CELATA, Hall.

Fig. 1. A pedicle-valve from which the shell is partially exfoliated; showing traces of the curved lateral and the central scars. ×2.

Fig. 2. A pedicle-valve retaining most of the shell; (*a*) longitudinal section showing the elevation of the beak; (*b*) posterior elevation. ×2.

Fig. 3. A brachial valve; showing the central and lateral muscular impressions and a very sharply defined scar (*z*), which, if not adventitious, may be homologous with the external scars in OBOLELLA or the terminal crescent scars in the Trimerellids. ×2.

Fig. 4. A portion of an internal cast of the brachial valve. ×2.
Middle Cambrian. *Near Troy, N. Y.*

OBOLELLA, BILLINGS.

Page 240.

OBOLELLA CRASSA, Hall.

Fig. 5. The exterior of a valve; showing the radiating striæ between the lamellose growth-lines. × 2.

Fig. 6. The interior of the brachial valve; showing the faint pedicle-groove, the cardinal, external, central and lateral muscular impressions. × 2,

Fig. 7. The interior of a pedicle-valve; showing the pedicle-groove, the cardinal, lateral and central muscular scars. × 2.
Middle Cambrian. *Near Troy, N. Y.*

LEPTOBOLUS, HALL.

Page 241.

LEPTOBOLUS INSIGNIS, Hall.

Fig. 8. The exterior of the shell; showing the concentric and radiating striæ. × 8.
Utica slate. *Middleville, N. Y.*

Fig. 9. An internal cast of the pedicle-valve; showing the long, curved lateral scars and a faint indication of the posterior muscular depression. × 10.
Utica slate. *Holland Patent, N. Y.*

Fig. 12. The interior of a pedicle-valve; showing the cardinal area and pedicle-groove, and the calloused fulcra of the lateral muscles. The posterior area is depressed and bears the impression of the central muscles on its pitted surface.

Hudson river group (Utica horizon). *Covington, Kentucky.*

LEPTOBOLUS LEPIS, Hall.

Fig. 10. The interior of a pedicle-valve; showing the cardinal groove and the diverging septa. × 12.

Fig. 11. The interior of the brachial valve; showing the grooved cardinal area and the median and lateral septa, each of which is bifurcate at its extremity. × 12.

Hudson River group. *Licking River, Ohio.*

ELKANIA, FORD.

Page 241.

ELKANIA DESIDERATA, Billings (sp.).

Fig. 13. The interior of the pedicle-valve; showing the deep central impression, subcardinal, crescentic and external scars, the diverging vascular (genital?) furrows and the broad, deep lateral depressions, probably not of muscular origin. × 3.

Fig. 14. The interior of a brachial valve, with the impressions of the centra and lateral muscles and the crescent. × 3.

Quebec group. *Pointe Lévis.*

PATERULA, BARRANDE.

Page 242.

PATERULA (?), sp.

Fig. 15. The interior of a pedicle-valve, taken from a natural cast of the internal surface. The broad marginal border, narrow fissure and radiate muscular markings, indicate the close agreement of this fossil with PATERULA. × 5.

Quebec group. *South St. John's Market, Quebec.*

SCHIZOBOLUS, ULRICH.

Page 246.

SCHIZOBOLUS TRUNCATUS, Hall (sp.).

Fig. 16. The exterior of a pedicle-valve. × 3.

Fig. 17. The exterior of the brachial valve. × 3.

Genesee slate. *Western New York.*

Fig. 18. The interior of a pedicle-valve; showing the pedicle-slit, the composite muscular scars abutting against the median septum, and the long, curved lateral scars. × 5.

Fig. 19. The interior of the brachial valve; showing the septum and faintly defined muscular impressions. × 5.
Black slate (Genesee). *Madison county, Kentucky.*

DISCINOPSIS, MATTHEW.

Page 250.

DISCINOPSIS GULIELMI, Matthew.

Fig. 20. The exterior of a pedicle-valve?; showing the radiating and concentric lines, and a flattened apex which may indicate the position of the foramen. × 5.

Fig. 21. The interior of the pedicle-valve, with the linguiform median extension sharply defined, and showing the probable position of the foramen. × 5.
St. John group. *Portland, New Brunswick.*

LINNARSSONIA, WALCOTT.

Page 251.

LINNARSSONIA TRANSVERSA, Hartt.

Fig. 22. The interior of a brachial valve; showing the median and lateral septa and the large posterior scars. × 10.

Fig. 23. The interior of a pedicle-valve; showing the inner aperture of the foramen, the foraminal callosity and the cardinal tubercles. × 10.
St. John group. *Porter's Brook, New Brunswick.*

ACROTHELE, LINNARSSON.

Page 249.

ACROTHELE MATTHEWI, Hartt (sp.).

Fig. 24. The interior of a brachial valve; showing the median septum and adjacent muscular scars. × 8.
St. John group. *Portland, New Brunswick.*

ACROTHELE MATTHEWI, Hartt, var. LATA, Matthew.

Fig. 25. The interior of the pedicle-valve; showing the position of the foramen and the foraminal pits. × 8.

Fig. 26. An internal cast of the same valve. × 8.

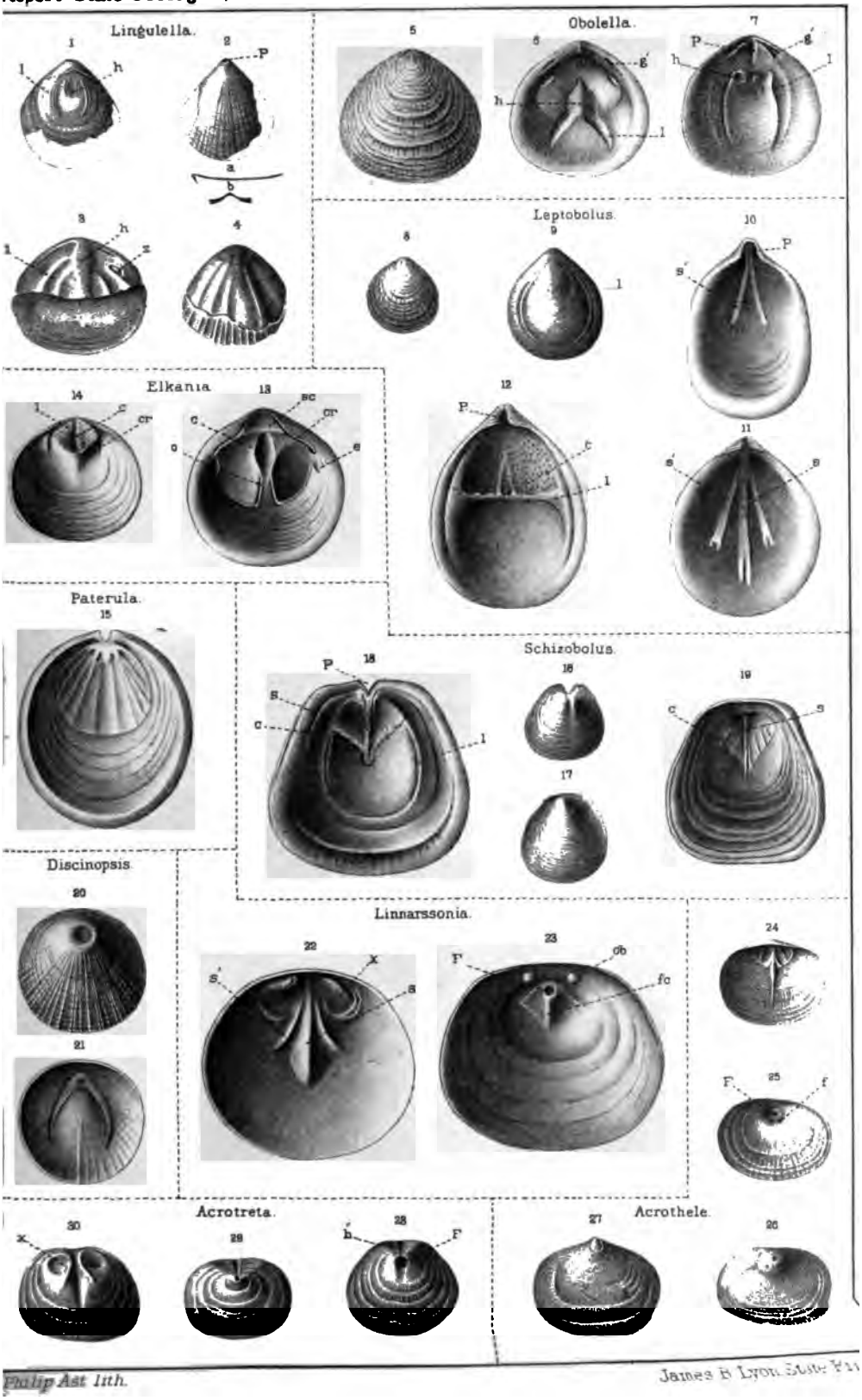
ACROTHELE MATTHEWI, Hartt (sp.), var. PRIMA, Matthew.

Fig. 27. The exterior of the pedicle-valve; showing the character of the surface ornamentation. × 8.
St. John group. *Hanford Brook, New Brunswick.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 3.



ACROTRETA, KUTORGA.

Page 250.

ACROTRETA BAILEYI, Matthew.

Fig. 28. An internal cast of a pedicle-valve; showing the grooved subapical area and the impression of the nipple-like swelling surrounding the foramen. × 4.

Fig. 29. The exterior of a pedicle-valve; showing the size of the outer foraminal aperture. × 4.

Fig. 30. An internal cast of the brachial valve. × 4.

St. John group. *Long Reach, King's county, New Brunswick.*

PLATE 4.

Legend. x. Composite laterals.
c. Composite centrals.
cd. Cardinal ridge.
F. Foramen.
P. Pedicle-groove.
S. Sipho.

CONOTRETA, WALCOTT.

Page 250.

CONOTRETA RUSTI, Walcott.

Fig. 1. An internal cast of a pedicle-valve; showing the impression of the strong apical callosity, and the radiating ridges. × 8.

Fig. 2. An apical view of the same valve; showing the subtriangular posterior slope, and its obscurely defined median furrow. × 9.

Fig. 3. Cardinal view of a very young individual, in which the posterior slope is very faint. × 12.

Trenton limestone. *Trenton Falls, N. Y.*

IPHIDEA, BILLINGS.

Page 249.

IPHIDEA BELLA, Billings.

Fig. 4. A pedicle-valve in which the subapical area is relatively small; showing the prominence of the cardinal ridge and the position of the foramen, which is not altogether distinct in the specimen. The figure is also slightly restored about the edges where the original is somewhat broken. × 3.

Fig. 5. Oblique view of the same, giving the elevation of the shell and the size of the cardinal ridge. × 3.

Georgia group. *Georgia, Vermont.*

HELMERSENIA, PANDER.

Page 254.

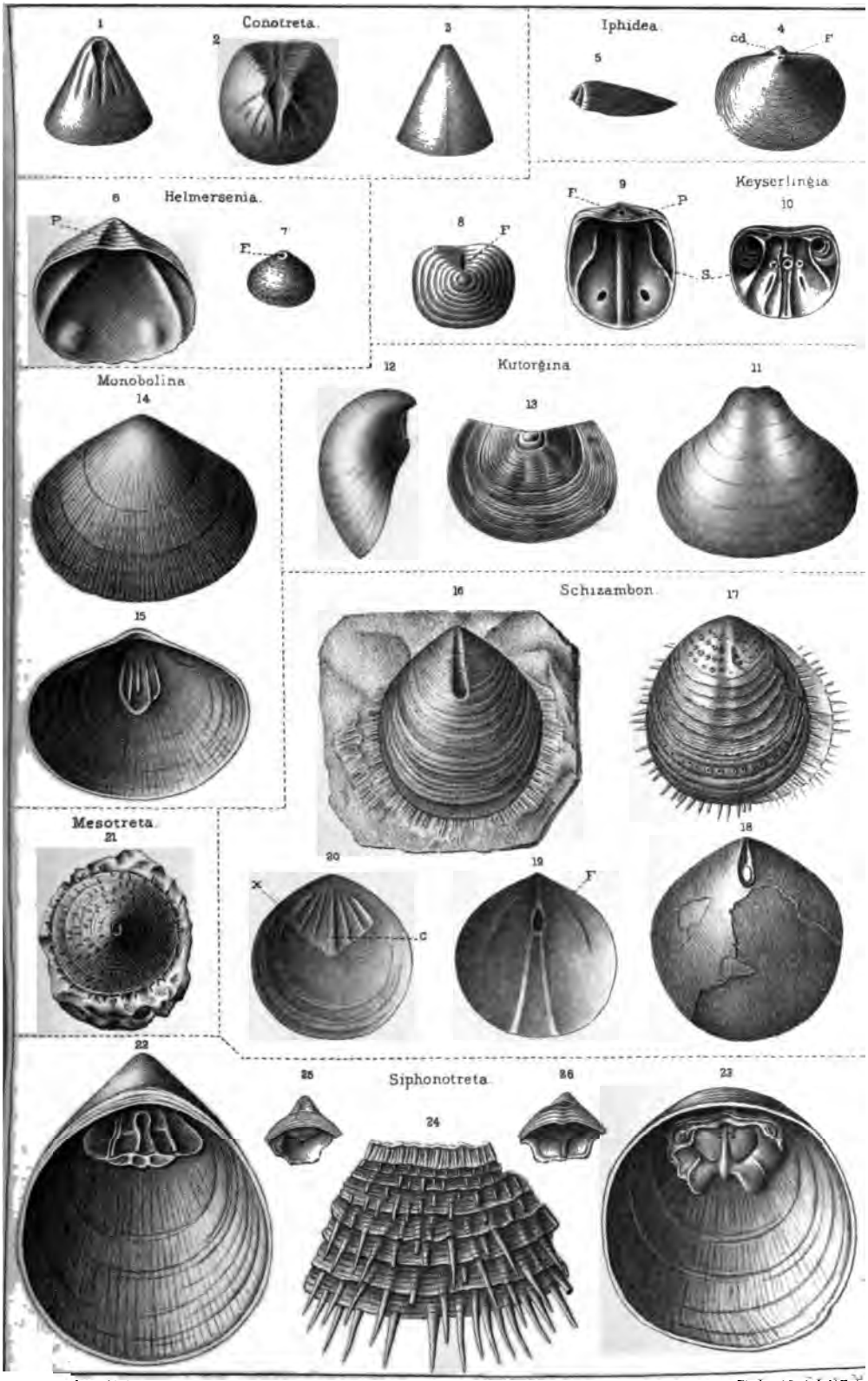
HELMERSENIA, sp.?

Fig. 6. The interior of a pedicle-valve. The cardinal area is broad and bears a median depression or deltidium, as if for the passage of the pedicle.

Fig. 7. The exterior of a similar valve: showing the apical aperature which, according to PANDER, is atrophied and blind. (PANDER.)

BRACHIOPODA.

Generic Illustrations.



KEYSERLINGIA, PANDER, 1861,=ORBICELLA, D'ORBIGNY, 1849.

Page 254.

KEYSERLINGIA BUCHII, De Verneuil.

Fig. 8. The exterior of the pedicle-valve; showing the slit-shaped opening of pedicle-passage.

Fig. 9. The interior of a pedicle-valve; showing the depressed or broadly grooved cardinal area, perforated by the opening of a sipho which is blind at its inner termination.

Fig. 10. The interior of a brachial valve; showing a blind internal tube, which is represented as broken, the cavity appearing in cross section.
Obolus beds. *River Ischora, Russia.*

The above figures are copies of those given by PANDER (Bull. de l'Acad. Imp. des Sciences de St. Petersbourg, vol. iii, p. 46, pl. ii, figs. 1, h, c, a), and represent the peculiar features assigned by him to the genus. The views are considerably enlarged.

KUTORGINA, BILLINGS.

Page 247.

KUTORGINA CINGULATA, Billings.

Fig. 11. A pedicle-valve with strongly incurved umbo. × 3.

Fig. 12. Profile of the same.

Fig. 13. A brachial valve in which the cardinal margin is truncate from incurvation. × 2.
Georgia group. *Swanton, Vermont.*

MONOBOLINA, SALTER.

Page 245.

MONOBOLINA PLUMBEA, Salter.

Fig. 14. Exterior of a brachial (?) valve. × 3.

Fig. 15. Interior of a similar valve. × 3. (DAVIDSON, Brit. Sil. Brach., pl. 1, figs. 23, 24.)

SCHIZAMBON, WALCOTT.

Page 253.

SCHIZAMBON FISSUS (Kutorga), var. CANADENSIS, Ami.

Fig. 16. A pedicle-valve retaining some of the surface spines and showing the external character of the pedicle passage. × 2.
Utica slate. *Gloucester, Ontario.*

Schizambon Minnesotensis.

Fig. 17. Dorsal view of a specimen retaining the valves in juxtaposition and preserving most of the epidermal layer of the shell. The spine-bases about the beak are noticeably large and more closely set than over the rest of the surface, where they occur at considerable intervals along the concentric varices. The entire length of the spines is evidently not represented in the fringe about the margin. × 2.

Trenton Limestone. *Minneapolis, Minnesota.*

Schizambon typicalis, Walcott.

Fig. 18. The exterior of a pedicle-valve from which a portion of the shell has been lost. × 5. (Walcott.)

Fig. 19. The interior of a pedicle-valve; showing the oval foramen with the posterior depressed, track and diverging muscular ridges. × 5.

Fig. 20. The interior of a brachial valve; showing the muscular area and its subdivision by divergent ridges. × 5.

Lower portion of the Pogonip group. *Eureka District, Nevada.*

MESOTRETA, Kutorga.

Page 251.

Mesotreta tentorium, Kutorga.

Fig. 21. The exterior of the pedicle-valve; showing its conical shape, perforated apex and spinulose exterior. (Kutorga.)

Lower Silurian. *Russia.*

SIPHONOTRETA, De Verneuil.

Page 252.

Siphonotreta unguiculata, De Verneuil.

Figs. 22, 23. The interior characters of both valves as given by Davidson. (Geological Magazine, 1877, pl. ii, figs. 9, 11.)

Fig. 24. A portion of the shell near the anterior margin, much enlarged to show the epidermal layer and the mode of origin of the hollow spines. (Kutorga.)

Fig. 25. The cardinal portion of the pedicle-valve; showing the inner extension of the sipho which is open. (Kutorga.)

Fig. 26. A similar portion of another valve in which the sipho is apparently closed. (Kutorga.)

PLATE 5.

Legend. F. Foramen.
p. Pedicle-area.
p'. Areal callosity.
g, g'. Listrium.
l. Lateral walls of listrium.
ar. Anterior muscular ridges.
s. Median septum.
aa. Anterior adductor scars.

SCHIZOTRETA, KUTORGA.

Page 257.

SCHIZOTRETA OVALIS, Hall.

Fig. 1. A pedicle-valve from which the shell has been partially broken; showing the short foraminal groove. × 3.

Fig. 2. Profile view of the same specimen; showing the convexity of the conjoined valves. × 3.

Trenton limestone. *Middleville, N. Y.*

SCHIZOTRETA CONICA, Dwight.

Fig. 3. Outline profile of the conjoined valves. After DWIGHT.

Fig. 4. The external characters of the pedicle-area. × 3.

Trenton limestone. *Newburgh, N. Y.*

ŒHLERTELLA, HALL.

Page 257.

ŒHLERTELLA PLEURITES, Meek. (sp.)

Fig. 5. The interior of a pedicle-valve; showing the elevated pedicle ridge and the open marginal foramen.

Fig. 6. A profile of the same; showing the internal elevation of the pedicle-area.

Fig. 7. Exterior of a brachial valve; showing the posterior position of the apex.

Fig. 8. The internal characters of the pedicle-area; showing the open marginal foramen, the elevated, radially striated lateral walls, and the median ridge of the listrium and a short apical septum. × 3.

Waverly group. *Newark, Ohio.*

RŒMERELLA, HALL.

Page 257.

RŒMERELLA GRANDIS, Vanuxem.

Fig. 9. The exterior of a brachial valve.

Hamilton limestone. *Falls of the Ohio.*

Fig. 10. The exterior of a pedicle-valve from which the shell has been partially exfoliated, exposing the cast of the external pedicle-groove.

Hamilton group. *Cazenovia, N. Y.*

ORBICULOIDEA, D'ORBIGNY.

Page 256.

ORBICULOIDEA PULCHRA, Hall.

Fig. 11. The exterior of a pedicle-valve. × 1.5.

Fig. 17. The interior portion of the pedicle-area; showing the callosites which have enveloped the various divisions of the area.

Cuyahoga shale. *Berea, Ohio.*

ORBICULOIDEA MANHATTANENSIS, Meek and Hayden.

Fig. 12. The interior of a pedicle-valve; showing the character of the pedicle-area, the radiating vascular lines, and where the shell is broken on the anterior portion, the character of the external ornamentation and the unusual thickness of the valve.

Coal measures. *Riley county, Kansas.*

ORBICULOIDEA MEDIA, Hall.

Fig. 13. The exterior of a pedicle-valve.

Chemung group. *Troupsburg, N. Y.*

Fig. 14. The exterior of a brachial valve.

Hamilton group. *Seneca county, N. Y.*

ORBICULOIDEA RANDALLI, Hall.

Fig. 15. The exterior of a pedicle-valve; showing, from compression, the apical muscular ridge, the radiating pallial sinuses and the internal track of the pedicle-furrow extending toward the margin and interrupting the concentric growth-lines. The overlapping marginal portion of the opposite valve is seen about the posterior arc of the circumference. Natural size.

Hamilton group. *Near Schoharie, N. Y.*

ORBICULOIDEA NITIDA, Phillips.

Fig. 16. The pedicle-area of an extremely young shell, having a diameter of 1 mm. The foramen is a marginal slit extending, with divergent edges, for almost the entire radius of the valve. At the apex, the listrium appears in an incipient stage. × 50.

Lower Coal measures. *Springfield, Illinois.*

LINDSTRŒMELLA, HALL,

Page 257.

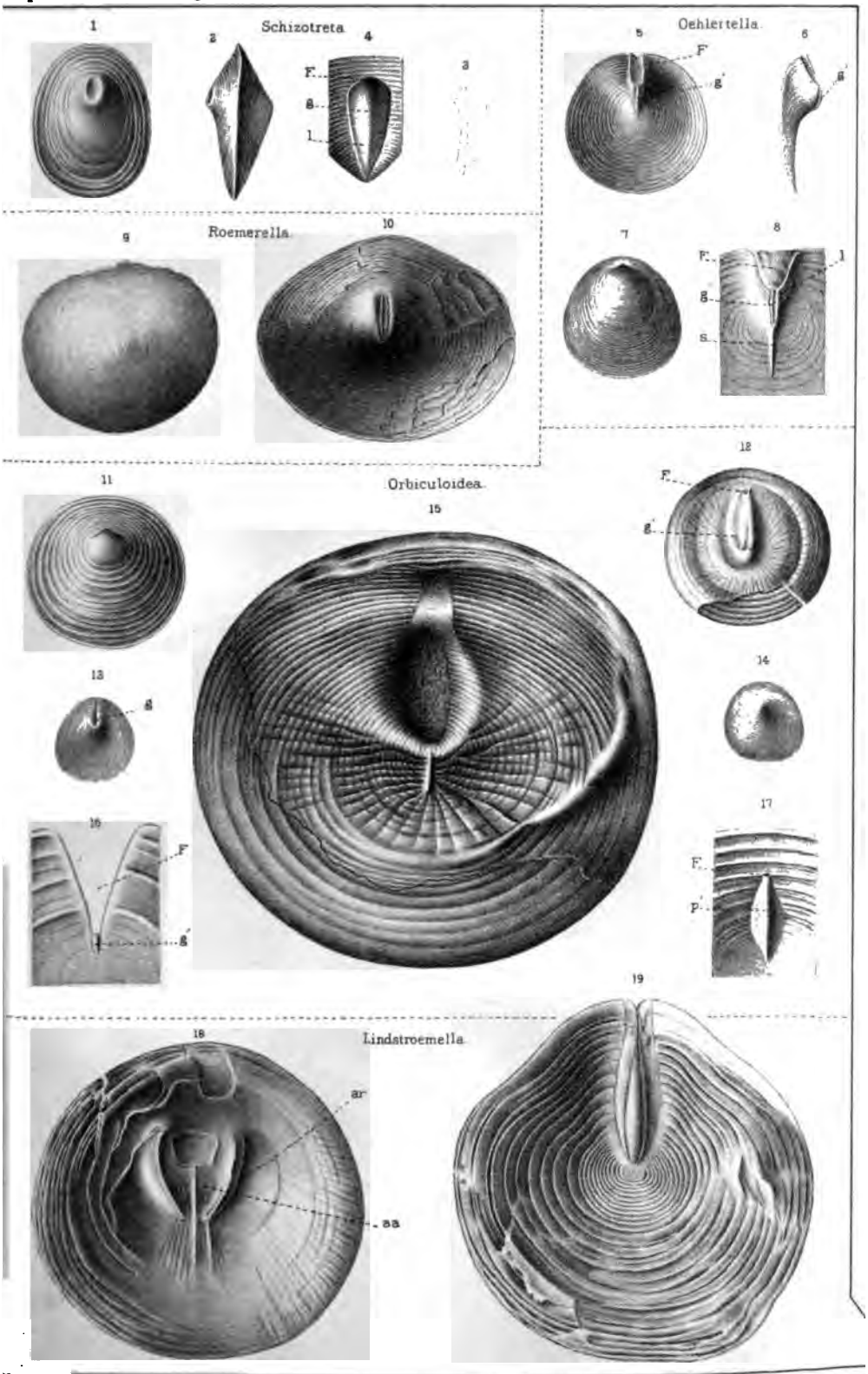
LINDSTRŒMELLA ASPIDIUM, Hall.

Fig. 18. The interior of a brachial valve; showing the great lateral ridges and low median septum. At the posterior extremities of the former are seen two small subcircular muscular impressions, while the scars of the anterior adductors are strongly developed. Natural size.

Hamilton group. *Near Hamilton, N. Y.*

BRACHIOPODA.
Generic Illustrations.

Report State Geologist, 1891. Plate 5.



Lith.
James B Lyon & Co. Prs

Fig. 19. A natural cast of the exterior of a large pedicle-valve believed to belong to this species; showing the character of the surface ornamentation, and the peculiar undulation of the concentric ridges on approaching the pedicle-area. The pedicle-passage differs from that in the normal mature ORBICULOIDEA, in not being closed, though its margins appear to be in contact. The characters of this area as represented in the drawing, have been slightly restored from other specimens.

Hamilton group. *Near Leonardsville, N. Y.*

PLATE 6.

Legend.
B. Brachial valve.
P. Pedical-valve.
F. Foramen.
g, g'. Listrium.
l. Walls of listrium.
s. Medianse ptum.
o. Posterior muscular scars.
re. Extremital scars.
b. Brachial muscular scars.
m. Median muscular fulcrum.
c. Central scars.
pc. Posterior centrals.
cc. Median centrals.
ac. Anterior centrals.
pa. Posterior adductors.
pa'. Anterior element of posterior adductors.
aa. Anterior adductors.
v. Vascular sinuses.

TREMATIS, SHARPE.

Page 258.

TREMATIS TERMINALIS, Emmons.

Fig. 1. An internal cast of the pedical-valve; showing the great depression of the pedicle-area, the median ridge corresponding to the pedicle-groove, and the vascular sinuses. × 3.
Trenton limestone. *Middleville, N. Y.*

TREMATIS MILLIPUNCTATA, Hall.

Fig. 2. The exterior of a brachial valve, from which the shell is partially exfoliated. × 2.

Fig. 3. Profile of an internal cast of the conjoined valves.

Fig. 4. Ventral view of the same specimen, exposing the pedicle-valve and the projecting apical portion of the brachial valve. × 2.
Hudson River group. *Cincinnati, Ohio.*

Fig. 5. The interior of a brachial valve; showing the posterior callosity forming a surface for the passage of the pedicle, the external muscular scars and the components of the central impressions. × 2.
Hudson River group. *Covington, Ky.*

Fig. 6. The external ornamentation. × 25.

TREMATIS, sp., compare T. PUNCTOSTRIATA, Hall.

Fig. 7. The internal pedicle-area; showing the elevation of the margins of the fissure. × 4.
Hudson River group. *Frankfort, Ky.*

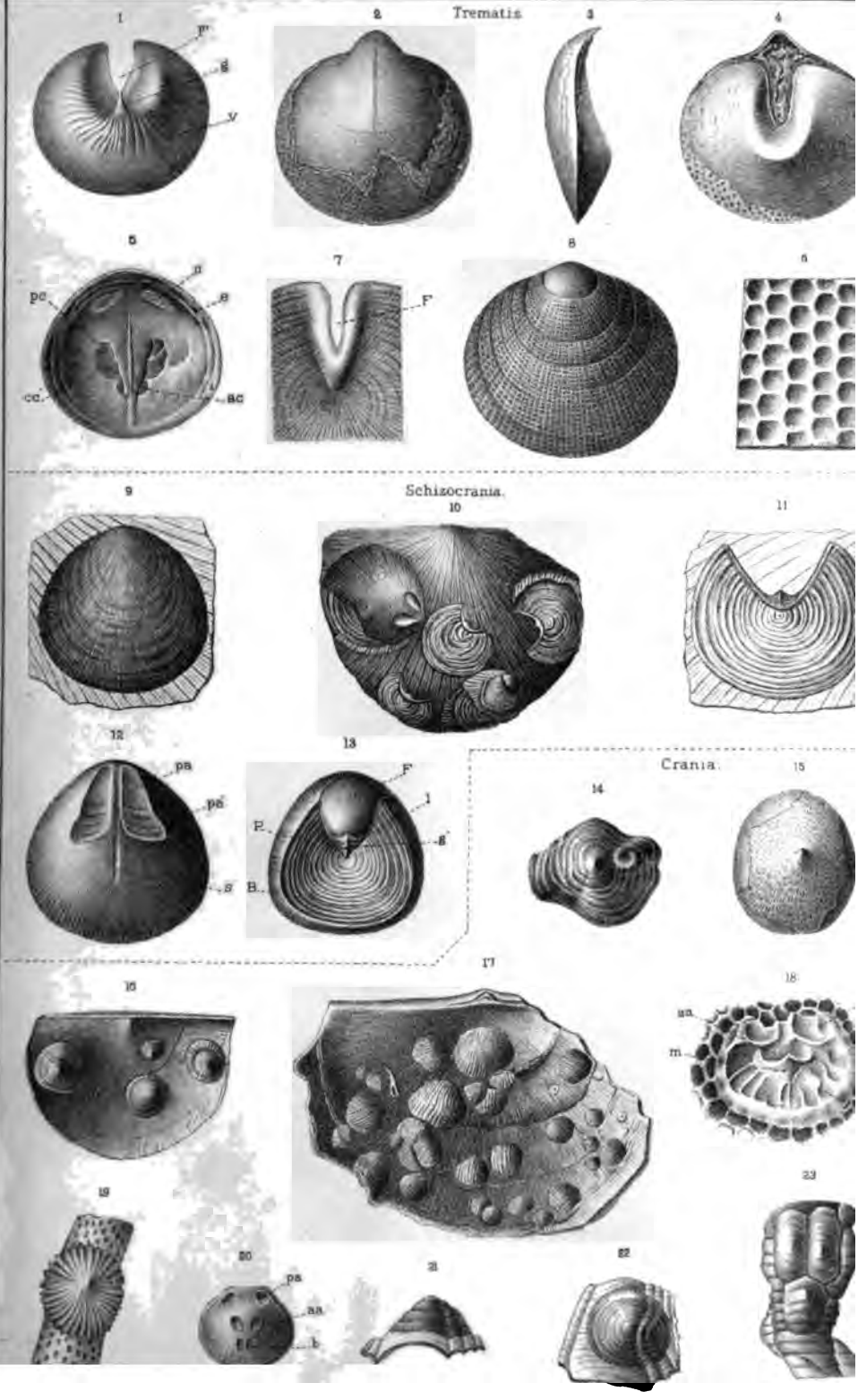
TREMATIS OTTAWENSIS, Billings.

Fig. 8. External view of a brachial valve. From a gutta-percha cast of the exterior. Natural size.
Trenton horizon. *Frankfort, Ky.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate



James B. Lyon, St.

SCHIZOCRANIA, HALL and WHITFIELD.

Page 259.

SCHIZOCRANIA FILOSA, Hall.

Fig. 9. The exterior of a brachial valve attached to *Rafinesquina alternata.*

Fig. 10. A valve of *Rafinesquina alternata* to which five of these shells are attached, all of them exposing the lower valve.

This figure is taken from the Palæontology of Ohio, vol. ii, pl. i, fig. 12. and the muscular scars on the internal cast of the upper valve, shown in the left of the figure, remain as there represented.

Fig. 11. The pedicle-valve; showing the wide incision and the apical callosity.

Fig. 12. An internal cast of the brachial valve; showing the elongate muscular scars separated into anterior and posterior elements; also a faint median ridge extending forward beyond the muscular area.

Hudson River group. *Cincinnati, Ohio.*

Fig. 13. An individual from which the upper portion of the brachial valve has been removed, exposing all the internal characters of the pedicle-valve.

It will be observed that in this figure, as well as in fig. 10, the diameter of the lower valve is less than that of the upper, and as the former lies above and within the margin of the latter, the attachment of the shell being largely effected by the marginal portions of the larger valve.

Hudson River group. *Covington, Ky.*

CRANIA, RETZIUS.

Page 260.

CRANIA GRANOSA, Hall.

Fig. 14. A somewhat distorted upper valve, showing the finely granulose surface.

Hamilton group. *Centerfield, N. Y.*

CRANIA SETIFERA, Hall.

Fig. 15. A somewhat imperfect upper valve.

Niagara group. *Waldron, Ind.*

CRANIA LÆLIA, Hall.

Fig. 16. Four individuals attached to the pedicle-valve of *Strophomena planumbona.*

Hudson River group. *Oxford, Ohio.*

CRANIA SCABIOSA, Hall.

Fig. 17. A brachial valve of *Rafinesquina alternata,* covered with shells of this species, all of which carry the radiating and fine concentric ornamentation of the host.

Hudson River group. *Cincinnati, Ohio.*

CRANIA FAVINCOLA, Hall.

Fig. 18. A lower valve, slightly broken about the posterior margin, but showing the very large posterior muscular impressions, the deeply impressed anteriors, with sharply elevated margins and median fulcrum; also the radiating pallial sinuses. The shell is attached to a specimen of *Favosites pirum*, Davis.

Hamilton group. *Crab Orchard, Ky.*

CRANIA PULCHELLA, Hall.

Fig. 19. An individual attached to a branch of *Trematopora;* showing the coarse radiating ribs. × 2.

Lower Helderberg group. *Near Clarksville, N. Y.*

CRANIA LEONI, Hall.

Fig. 20. The interior of an upper valve; showing, in addition to the posterior and anterior adductor scars, the faint impressions of the brachial muscles.

Chemung group. *Leon, N. Y.*

CRANIA BORDENI, Hall and Whitfield.

Fig. 22. An individual attached to a valve of *Spirifer Oweni;* showing the very fine radiating striæ, and the conformation of the upper valve to the surface of attachment.

Fig. 21. Profile of the same specimen.

Hamilton limestone. *Clarke county, Ind.*

CRANIA SOCIALIS, Ulrich (= *Crania scabiosa*, Hall).

Fig. 23. A fragment of a crinoid column, covered with individuals which retain very distinctly the impressions of the sutures between the segments. × 3.

Hudson River group. *Covington, Ky.*

PLATE 7.

Legend. pa. Posterior adductors.
aa. Anterior adductors.
da. Dorsal adjustors.
va. Ventral adjustors.
mm. Mesenteric muscular impressions.
p. Parietal impression.
m. Median impression.
b. Brachial muscular impression.
v. Vascular trunks.
v'. Vascular branches.

ANCISTROCRANIA, DALL.

Page 261.

ANCISTROCRANIA PARISIENSIS, Defrance.

Fig. 1. The interior of the attached valve.

Fig. 2. The interior of the upper valve. (ŒHLERT.)
Cretaceous. *France.*

CRANISCUS, DALL.

Page 261.

CRANISCUS TRIPARTITUS, Münster.

Fig. 3. The interior of the attached valve; showing the divisions of the internal chamber. (Davidson.)
Jurassic.

CRANIELLA, ŒHLERT.

Page 262.

CRANIELLA HAMILTONIÆ, Hall.

Fig. 4. An internal cast of a large upper valve; showing the usual muscular scars and the peculiar sigmoid vascular trunks with their ramifications.
Hamilton group. *Pratt's Falls, N. Y.*

Fig. 5. An internal cast of a convex and apparently free lower valve; showing the closer approximation of the anterior and posterior adductor scars than in the opposite valve, the deep impression of the mesenteric muscle, and the radiating vascular sinuses. The figure is slightly restored on the left side. × 2.
Hamilton group. *Centerfield, N. Y.*

Fig. 6. The interior of an attached valve. From Palæontology of New York, vol. iv, pl. iii, fig. 23.

Fig. 7. Profile view of a normal shell, attached to *Tropidoleptus carinatus.*
Hamilton group. *Canandaigua Lake, N. Y.*

CRANIELLA ULRICHI. Hall.

Fig. 8. The internal cast of an upper valve. The sigmoid vascular impressions are simpler than elsewhere observed; the scars of the dorsal adjustors and of muscles accessory to the anterior adductors (possibly the brachial muscles) are also apparent.
Drawn from a gutta-percha cast of a natural interior. × 1.5.
Trenton limestone. *Minneapolis, Minnesota.*

CARDINOCRANIA, Waagen.

Page 262.

Cardinocrania Indica, Waagen.

Figs. 9, 10. Interiors of attached valves. (Waagen.)
Carboniferous group. *India.*

PSEUDOCRANIA, McCoy.

Page 261.

Pseudocrania divaricata, McCoy.

Fig. 11. The exterior of the shell.

Fig. 12. The interior of a ventral (?) valve.

Fig. 13. The interior of the opposite valve. (Davidson.)
Lower Silurian. *Great Britain.*

PHOLIDOPS, Hall.

Page 262.

Pholidops Hamiltonia, Hall.

Figs. 14, 15. Ventral (?) and profile views of conjoined valves.

Fig. 16. The interior of a ventral (?) valve; showing the character of the muscular impressions. × 8.

Fig. 17. The interior of the opposite valve; showing the muscular and parietal scars. × 4.
Hamilton group. *Canandaigua Lake, N. Y.*

Pholidops Cincinnatensis, Hall.

Fig. 18. The exterior of a normal specimen. × 4.
Hudson River group. *Cincinnati, Ohio.*

Pholidops linguloides, Hall. (?)

Fig. 19. The interior of a dorsal (?) valve: showing the terminal and slightly deflected beak, the subapical area and the character of the muscular scars. × 2.
Hamilton group. *Eighteen Mile Creek, N. Y.*

Pholidops areolata, Hall.

Fig. 20. An internal cast of the dorsal (?) valve. × 3.
Schoharie grit. *Knox, N. Y.*

Fig. 21. An internal cast of the opposite valve. × 3.
Schoharie grit. *Near Clarksville, N. Y.*

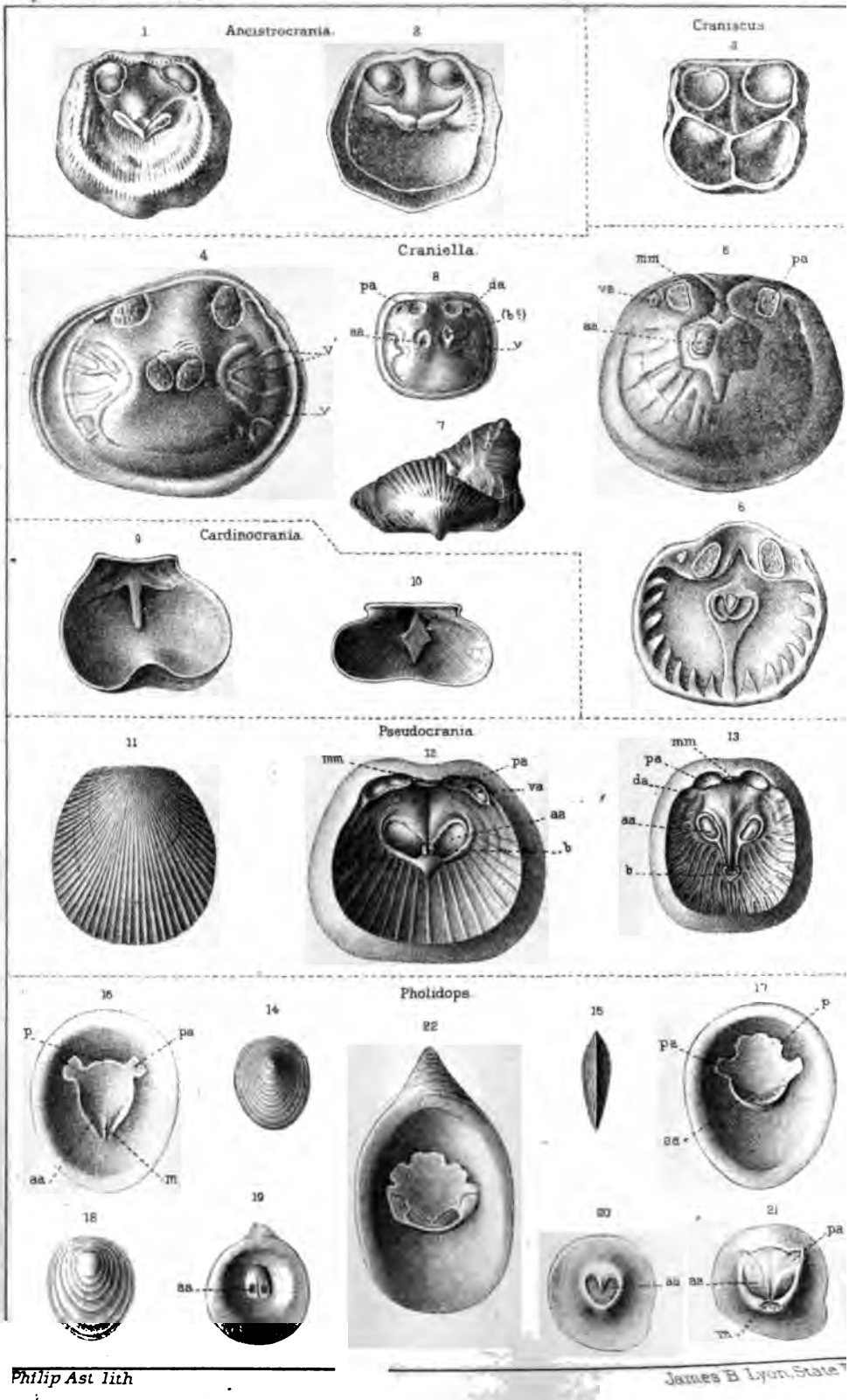
Pholidops calceola, Hall.

Fig. 22. The interior of a dorsal (?) valve; showing the terminal beak; subapical area and the character of the muscular impressions. × 12.
Corniferous limestone. *Falls of the Ohio.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 7



Philip Ast lith

James B Lyon, State

PLATE 8.

Legend.
- D. Deltidium.
- j. Cardinal process.
- t. Teeth.
- l (d). Spondylium.
- fp. Crual plates.
- c. Crura.
- DA. Cardinal area, brachial valve.
- VA. Cardinal area, pedicle-valve.
- F. Foramen.
- C. Chilidium.
- s. Median septum.
- s'. Lateral septum.
- s''. Accessory lateral septum.
- a. Anterior adductor impressions.
- a'. Posterior adductor impressions.
- d. Dental lamellæ.

BILLINGSELLA, HALL.

Page 273.

BILLINGSELLA PEPINA, Hall.

Fig. 1. The interior of the pedicle-valve showing the broad cardinal area, the convex deltidium, teeth, outline of the muscular area and a single pair of vascular trunks. × 3.

Fig. 2. The interior of a brachial valve; showing the minute, linear cardinal process, and the small, slightly divergent crural plates. × 3.

Potsdam sandstone. *Lake Pepin, Wisconsin.*

PROTORTHIS, HALL.

Page 273.

PROTORTHIS BILLINGSI, Hartt.

Fig. 3. The exterior of a small pedicle-valve; showing the concave plate or spondylium which closes the delthyrium below. × 3.

Fig. 4. A cardinal view of the same specimen. × 3.

Fig. 5. The exterior of a pedicle-valve. × 2.

Fig. 6. The central cardinal portion of the brachial valve; showing the broad delthyrium with a thickened area at its base, and the absence of a cardinal process. × 6.

Fig. 7. The interior of a brachial valve. × 2.

St. John group. *Ratcliff's mill, near St. John, New Brunswick*

CLITAMBONITES, PANDER.

Page 274.

CLITAMBONITES ADSCENDENS, Pander.

Fig. 8. A cardinal view, giving the subpyramidal contour characterizing this genus; showing also the foramen in the deltidium. × 2.

Fig. 9. A pedicle-valve with the apex cut away; showing the peculiar internal construction of this valve. × 2.

Lower Silurian. *Russia.*

CLITAMBONITES (ORTHISINA) ANOMALA, Schlotheim.

Fig. 10. A view of the pedicle-valve; showing the great retrorsion of the apex, the high cardinal area of the pedicle-valve, and the perforated deltidium; and also the area and chilidium of the opposite valve. (After DE VERNEUIL, Géol. Russ. et des Mont. de l'Oural, plate xii, fig. 2*b*.)

Fig. 11. The interior of a pedicle-valve. (After DAVIDSON.)

Fig. 12. The interior of the brachial valve: showing the extreme development of the cardinal area and chilidium, the latter entirely obscuring the cardinal process; the character of the muscular and vascular scars is also distinctly seen. (After DAVIDSON.)

Lower Silurian. *Russia.*

CLITAMBONITES VERNEUILI, (von Eichwald) Billings.

Fig. 13. The interior of a pedicle-valve, showing the simple cardinal process abutting against the chilidium, and the quadripartite impression of the adductor muscles.

Trenton horizon. *Island of Anticosti.*

HEMIPRONITES, PANDER.

Page 275.

HEMIPRONITES, sp. ?

Fig. 14. A cardinal view of conjoined valves; showing the characteristic contour upon which is based the separation of these forms from CLITAMBONITES. × 2.

Fig. 15. A specimen cut horizontally across the umbonal region of the pedicle-valve; showing the united dental lamellæ supported by a median septum. × 2.

Lower Silurian. *Russia.*

POLYTOECHIA, HALL.

Page 275.

POLYTOECHIA APICALIS, Whitfield.

Figs. 16, 17, 18. Three views of the original specimens of the species, the last showing the high cardinal area and convex deltidium. × 3.

Fig. 19. The interior of the cardinal portion of the pedicle-valve. The deltidium has been removed, exposing the concave spondylium supported by median and lateral septa. × 3.

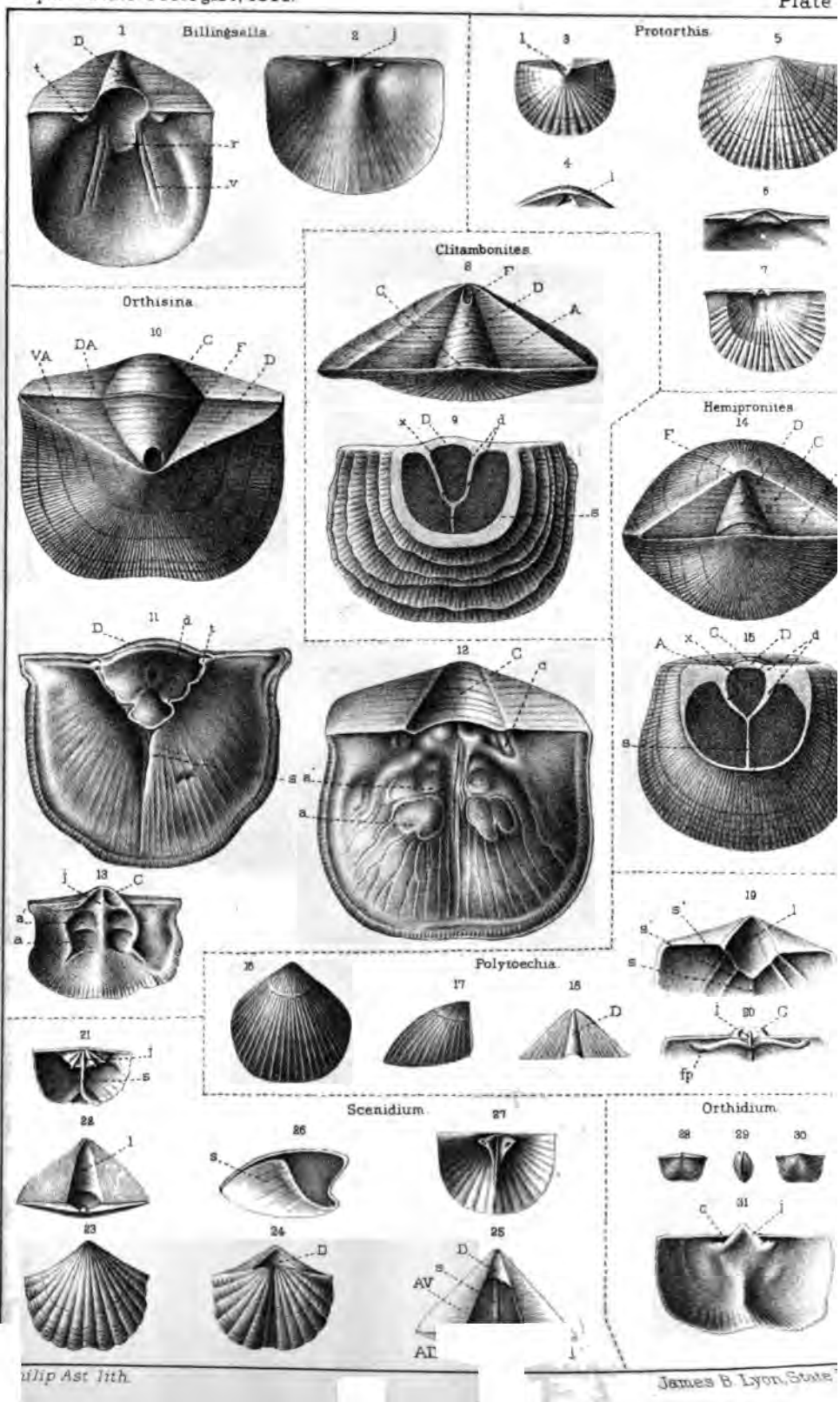
Fig. 20. The cardinal portion of the brachial valve; showing in profile the lateral portions of the chilidium partially inclosing the simple cardinal process. The socket walls are very divergent and nearly parallel to the hinge-line. × 3.

Calciferous beds. *Fort Cassin, Vermont.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate



Tulip Ast. lith. James B. Lyon, State

SCENIDIUM, HALL.

Page 276.

SCENIDIUM PYRAMIDALE, Hall.

Fig. 22. A cardinal view of the pedicle-valve, showing the spondylium.
Niagara group. *Lockport, N. Y.*

SCENIDIUM INSIGNE, Hall.

Fig. 21. The interior of the brachial valve; showing the elevated hinge-plate and the prominent median septum. × 8.

Figs. 23, 24. Dorsal and ventral views of conjoined valves; showing the character of the exterior. × 8.

Fig. 25. A cardinal view of conjoined valves; showing the concave plate in the delthyrium (p), the hinge-plate (A) and the median septum (S). × 8.

SCENIDIUM AREOLA, Quenstedt.

Fig. 26. A longitudinal section of the two valves; showing the extension of the median septum into the cavity of the pedicle-valve. (DAVIDSON.)

SCENIDIUM HALLI, Safford.

Fig. 27. The interior of a brachial valve; showing the triangular hinge-plate resting on the bottom of the valve, and the low median septum extending beyond the middle of the shell. × 4.
Trenton limestone. *Nashville, Tennessee.*

ORTHIDIUM, HALL.

Page 276.

ORTHIDIUM GEMMICULA, Billings.

Figs. 28, 29, 30. Three views of this shell. (After BILLINGS.)

Fig. 31. The interior of a brachial valve; showing the simple, erect cardinal process, coalesced with the crural plates. × 4.
"*Point Lévis; in the upper part of the Limestone No. 2, Quebec group.*" (BILLINGS.)

PLATE 9.

Legend. Δ. Deltidium.
t. Teeth.
j. Cardinal process.
fp. Crural plates.
a. Anterior adductor impressions.
a'. Posterior adductor impressions.
r. Anterior diductor impressions.
r'. Posterior diductor impressions.
v. Vascular markings
s'. Deltidial plate or callosity.
o. Ovarian markings.

ORTHIS, DALMAN.

Pages 264, 265.

ORTHIS DAVIDSONI, de Verneuil.

Fig. 1. Interior of a pedicle-valve; showing the character of the cardinal and muscular areas.

Fig. 2. Profile of an individual having the valves in conjunction.

Fig. 3. A portion of the cardinal area of the brachial valve; showing the linear cardinal process, crural plates, thickened deltidial area and the low median ridge. × 3.

Upper Silurian limestone. *Island of Gotland.*

ORTHIS TRICENARIA, Conrad.

Figs. 4, 5. Dorsal and ventral views of a specimen with valves conjoined: showing the general exterior characters of this type of structure.

Fig. 6. The cardinal area of a pedicle-valve: showing the character of the apical callosity partially filling the delthyrium. × 3.

Trenton horizon. *St. Paul, Minnesota.*

Fig. 7. The interior of a brachial valve: showing the character of the cardinal process, crural plates and muscular area.

PLECTORTHIS, HALL.

Page 266.

ORTHIS PLICATELLA, Hall.

Fig. 8. The cardinal portion of the brachial valve, showing the cardinal process, crural plates and low median ridge. × 3.

Fig. 9. A similar portion of the pedicle-valve; showing the broad delthyrium, teeth and muscular area. × 3.

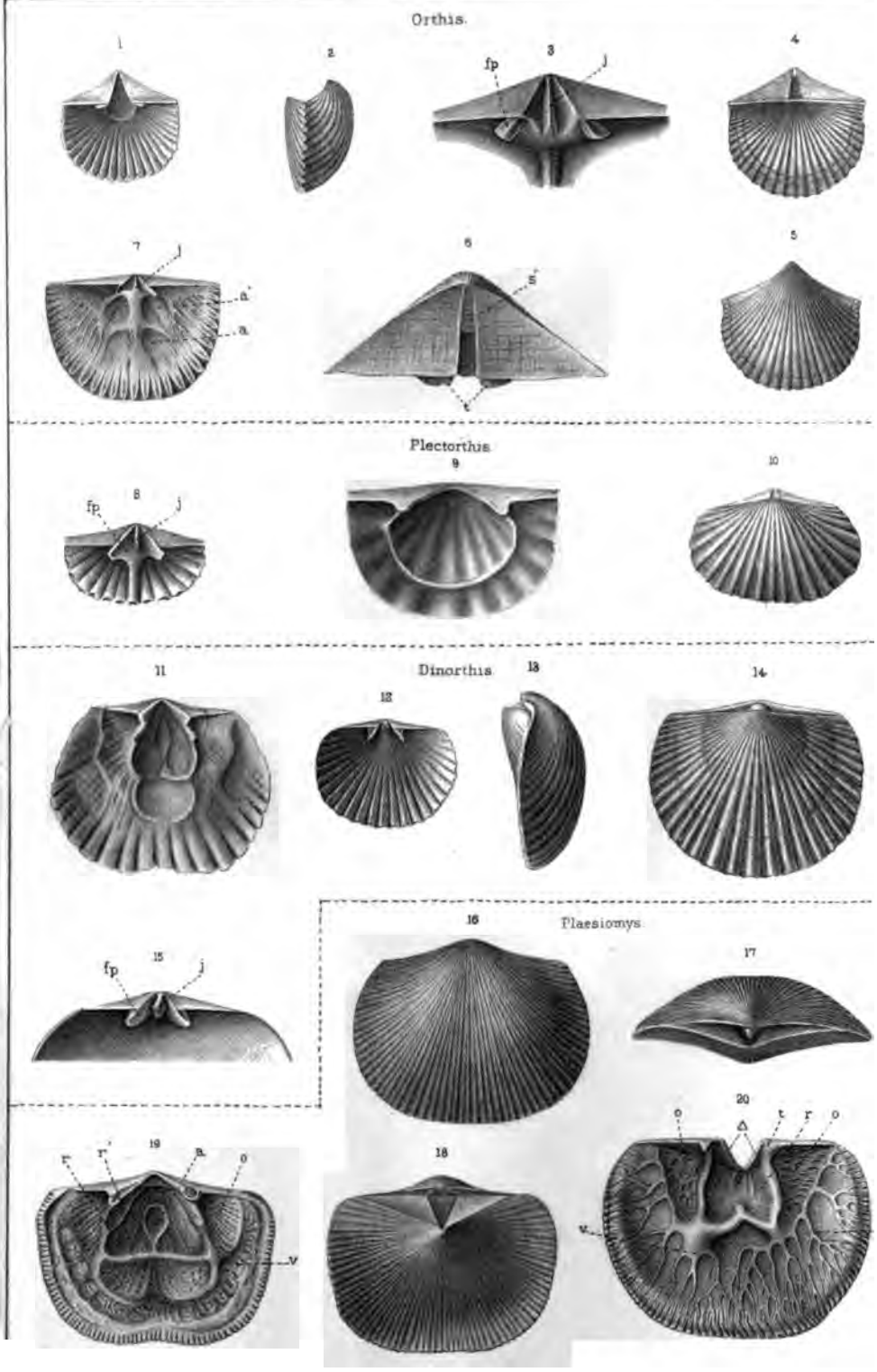
Fig. 10. Dorsal view of a normal adult, a strongly biconvex shell with a moderately low cardinal area and strong, distant, simple ribs.

Hudson River group. *Covington, Kentucky.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate



Philip Ast, lith. James B. Lyon, Stat

DINORTHIS, Hall.

Page 266.

Orthis pectinella (Emmons), Conrad.

Fig. 11. The interior of a pedicle-valve.

Fig. 13. A profile of conjoined valves; showing the reversed convexity.

Fig. 14. A ventral view of the same specimen.

Fig. 15. The cardinal portion of the brachial valve. × 3.
Trenton horizon. *Cardsville, Kentucky.*

Orthis Sweeneyi, N. H. Winchell.

Fig. 12. The interior of the brachial valve.
Trenton horizon. *St. Paul, Minnesota.*

PLAESIOMYS, Hall.

Page 266.

Orthis subquadrata, Hall.

Figs. 16, 17. Brachial and cardinal views of a normal individual.

Fig. 19. The interior of the pedicle-valve; showing the component scars of the subquadrate muscular area, the lateral ovarian areas and the vascular impressions over the pallial region.
Hudson River group. *Oxford, Ohio.*

Orthis retrorsa, Salter (= *O. Curleyi*, Hall).

Fig. 18. A ventral view of the original specimen: showing the high area and retrorse beak of the pedicle-valve.

Fig. 20. The interior of a pedicle-valve; showing the short dental lamellæ, subquadrate muscular area, the vascular and ovarian markings.
Hudson River group. *Oxford, Ohio.*

PLATE 10.

Legend. △. Deltidium.
j. Cardinal process.
fp. Crural plates.
t. Teeth.
b. Sockets.
a. Anterior adductor impressions.
a'. Posterior adductor impressions.
r. Diductor muscular impressions.
p. Pedicle-muscular impression.
o. Ovarian impressions.
v. Vascular markings.

HEBERTELLA, Hall.

Page 266.

Orthis sinuata, Hall.

Fig. 1. Dorsal view of a normal example.

Fig. 2. Profile view of the same specimen.

Fig. 3. The interior of a brachial valve.

Fig. 4. The interior of a pedicle-valve; giving the character of the muscular area, ovarian and vascular markings.

Hudson River group. *Cincinnati, Ohio.*

ORTHOSTROPHIA, Hall.

Page 267.

Orthis strophomenoides, Hall.

Fig. 5. The exterior of a brachial valve.

Fig. 6. A cardinal view of the same specimen.

Fig. 7. An internal cast of the brachial valve, retaining the impression of the simple cardinal process and showing the four sharply defined adductor scars, the ovarian markings and the ramified vascular sinuses.

Fig. 8. An internal cast of the pedicle-valve; showing the very small muscular area, the ovarian markings in the umbo-lateral regions, and the vascular sinuses over the pallial region.

Lower Helderberg group. *Near Clarksville, N. Y.*

PLATYSTROPHIA, King.

Page 268.

Orthis biforata, Schlotheim, var. lynx, von Eichwald.

Fig. 9. The interior of a brachial valve, showing the narrow, linear, cardinal process, large crural plates and the quadripartite impression of the adductor muscles.

Fig. 10. A cardinal view of an average individual; showing the area and delthyrium of each valve.

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 1(

Hebertella

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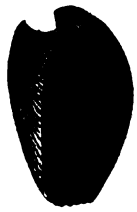

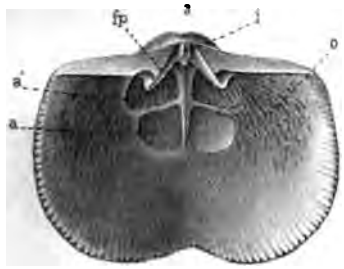

Orthostrophia

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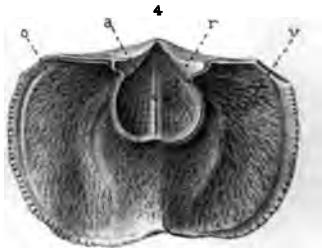

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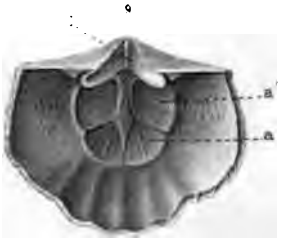

Platystrophia.

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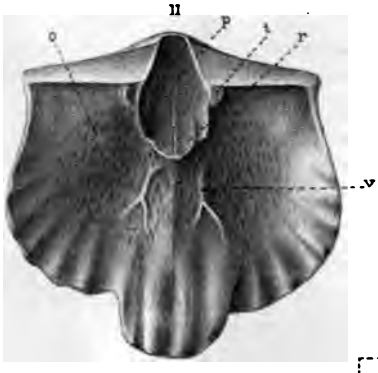


12

10

13

14

Bilobites.

18

19

16

15

17

James B Lyon, Stat

Fig. 11. The interior of a large pedicle-valve. The apical portion of the shell has been absorbed, this being the usual condition in old shells, thus exposing the impression of the pedicle-muscle. The specimen also shows the compact form of the muscular scars, the vascular trunks and ovarian markings.

Hudson River group. *Cincinnati, Ohio.*

ORTHIS BIFORATA, Schlotheim, var. LATICOSTA, Meek.

Figs. 12, 13. Front and profile views; showing the high median fold characterterizing this form.

Hudson River group. *Cincinnati, Ohio.*

BILOBITES, LINNÉ.

Page 269.

ORTHIS BILOBA, Linné.

Figs. 14, 15. Dorsal and ventral views of an average example. × 3.

Niagara group. *Lockport, N. Y.*

ORTHIS VARICA, Conrad.

Figs. 16, 17. Cardinal and dorsal views of the same specimen. × 2.

Fig. 18. The interior of the brachial valve; showing the cardinal process, the great crura, large muscular area, and the pectinated surfaces of marginal contact. × 5.

Fig. 19. The interior of the pedicle-valve; showing the area, delthyrium, teeth and outline of the muscular area. × 4.

Lower Helderberg group. *Near Clarksville, N. Y.*

PLATE 11.

Legend.
. Deltidium.
t. Teeth.
b. Sockets.
fp. Crural plates.
j. Cardinal process.
c. Crura.
a. Anterior adductor scars.
a'. Posterior adductor scars.
r. Diductor scars.
o. Ovarian markings.
v. Vascular markings.

HETERORTHIS, HALL.

Page 268.

ORTHIS CLYTIE, Hall.

Fig. 1. A dorsal view of the original specimen; showing cardinal area and foramen, and leptænoid exterior.

Fig. 2. The interior of a pedicle-valve; showing the elongate scars of the diductor muscles and the small adductor impressions.

Fig. 3. The interior of a brachial valve; showing the simple cardinal process and the elevated socket walls. Muscular area small and obscurely quadripartite.

Trenton horizon. *Near Frankfort, Kentucky.*

DALMANELLA, HALL.

Page 270.

ORTHIS TESTUDINARIA, Dalman.

Fig. 4. The interior of a pedicle-valve.

Fig. 5. The interior of a brachial valve.

Trenton horizon. *Mineral Point, Wisconsin.*

Fig. 6. Ventral view of the exterior of an average specimen.

Fig. 7. Profile of a somewhat larger shell.

Fig. 11. The central cardinal portion of a brachial valve, enlarged to show the structure of the articulating apparatus.

Hudson River group. *Cincinnati, Ohio.*

Also in Trenton limestone and Hudson River group, State of New York.

ORTHIS SUBÆQUATA, Conrad.

Fig. 9. The interior of a brachial valve; showing the slender cardinal process, the socket walls and adductor scars.

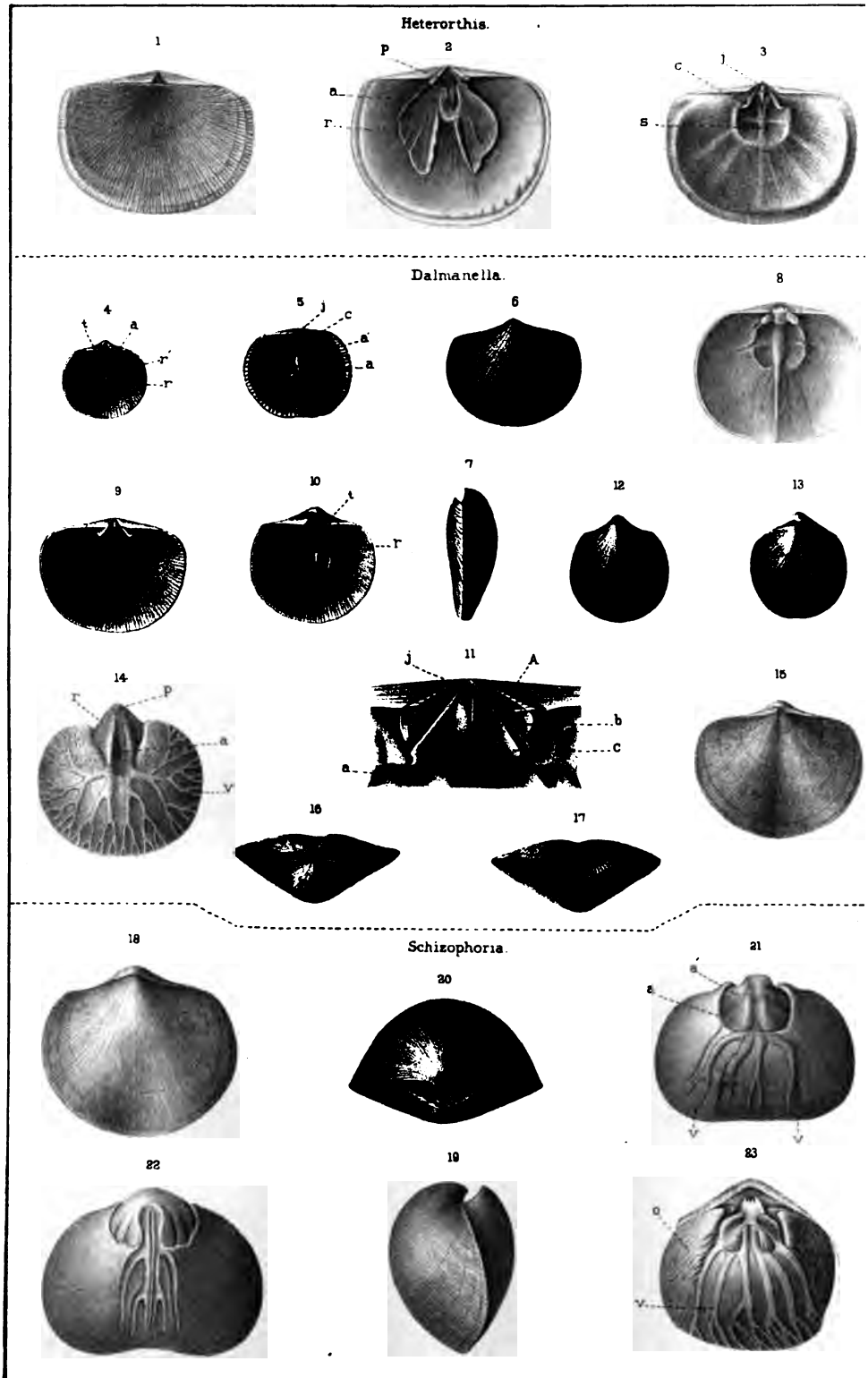
Fig. 10. The interior of the pedicle-valve; showing the form of the muscular impression.

Trenton horizon. *Mineral Point, Wisconsin.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate



ORTHIS ELEGANTULA, Dalman.

Figs. 12, 13. Ventral and dorsal views of the same individual; showing the form of the species as occurring at this locality.

Niagara group. *Waldron, Indiana.*

ORTHIS SUBCARINATA, Hall.

Fig. 8. The interior of a brachial valve.

Fig 14. A natural internal cast of the opposite valve, preserving the ramifications of the vascular sinuses, and showing also the ovarian spaces and muscular scars.

Figs. 15, 16, 17. Dorsal, cardinal and front views of the exterior of a normal individual; showing its form and contour.

Lower Helderberg group. *Near Clarksville, N. Y.*

SCHIZOPHORIA, KING.

Page 272.

ORTHIS TULLIENSIS, Hall.

Figs. 18, 19. 20. Three views of a normal individual; showing the great convexity of the brachial valve and the shallow pedicle-valve.

Tully limestone. *Keuka Lake, N. Y.*

ORTHIS PROPINQUA, Hall.

Fig. 21. An internal cast of the brachial valve. The subdivision and the course of the vascular sinuses are sharply retained.

Corniferous limestone. *Avon, N. Y.*

ORTHIS IMPRESSA, Hall.

Fig. 22. An internal cast of the pedicle-valve; showing the subdivisions of the muscular area, and the unusual arrangement of the vascular sinuses.

Fig. 23. An internal cast of the brachial valve; showing some difference in the number and arrangement of the vascular trunks.

Chemung group. *Lawrenceville, Pennsylvania.*

PLATE 12.

Legend.
A. Cardinal area.
t. Teeth.
b'. Sockets.
d. Dental lamellæ.
c. Crura.
s. Median septum.
j. Cardinal process.
p. Pedicle-area.
a. Anterior adductor scars.
a'. Posterior adductor scars.
r. Anterior diductor scars.
r'. Posterior diductor scars.
v. Vascular markings.
o. Ovarian markings.

RHIPIDOMELLA, Œhlert.

Page 271.

Orthis hybrida, Sowerby.

Figs. 1, 2. Two views of an average individual of the American form referred to this species.

Fig. 3. The interior of the pedicle-valve; showing the expanded muscular scars.

Niagara group. *Lockport, N. Y.*

Orthis Vanuxemi, Hall.

Fig. 4. The interior of a brachial valve, retaining with unusual distinctness the four scars of the adductor muscles. The ridges radiating from the anterior margin of the muscular area, are probably of vascular origin.

Hamilton group. *Canandaigua Lake, N. Y.*

Fig. 9. An internal cast of the pedicle-valve; showing the scar of the pedicle, diductor and adductor muscles.

Hamilton group. *Cumberland, Maryland.*

Orthis Michelini, L'Éveillé.

Fig. 5. A dorsal view of a specimen retaining the spines on a portion of its surface. (Davidson.)

Fig. 6. The interior of the pedicle-valve. (Davidson.)

Carboniferous limestone and shales. *Ayrshire, Scotland.*

Orthis Penelope, Hall.

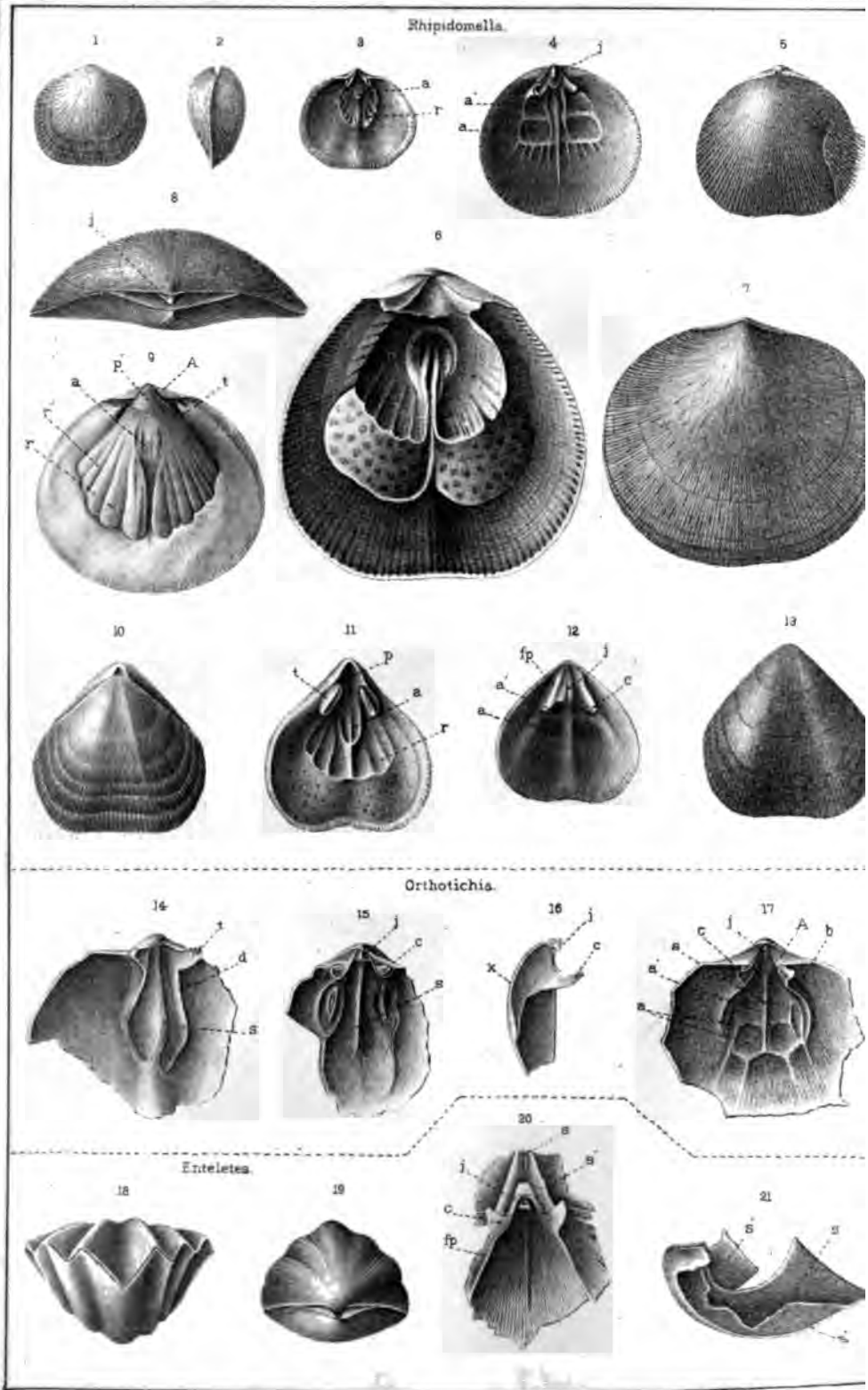
Figs. 7, 8. Ventral and cardinal views of a full-grown individual; showing the external characters.

Hamilton group. *Western New York.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate I



ORTHIS DUBIA, Hall.

Figs. 10, 13. Dorsal and ventral views of the exterior. × 2.
St. Louis group. *Lebanon, Kentucky.*

Fig. 11. The interior of the pedicle-valve; showing the division of the muscular area.
St. Louis group. *Litchfield, Kentucky.*

Fig. 12. The interior of the brachial valve; showing the cardinal process.
St. Louis group. *Lanesville, Indiana.*

ORTHOTICHIA, HALL.

Page 272.

ORTHIS MORGANIANA, Derby.

Fig. 14. The interior of a portion of the pedicle-valve; showing the elevation of the teeth and the outline of the muscular area.

Fig. 15. The interior of the brachial valve.

Fig. 16. Section in profile of the brachial valve; showing the extent of the crural plates and the elevation of the crura.

Fig. 17. The interior of another pedicle-valve; showing the muscular area in fuller detail.
Coal Measures. *Itaitubá, Brazil.*

ENTELETES, FISCHER DE WALDHEIM.

Page 272.

ENTELETES HEMIPLICATA, Hall.

Fig. 18. Frontal view of a mature individual: showing the characters of the exterior.
Coal Measures. *Winterset, Iowa.*

Fig. 19. A cardinal view of a younger shell.
Coal Measures. *Kansas City, Nebraska.*

Fig. 20. The interior of the rostral portion of the two valves in articulation. The median septum of the upper or pedicle-valve is broken off, but the lateral septa are retained. In the brachial valve are seen the high crural plates which are produced into strongly recurved crura. At (j) is the small lobate cardinal process, and in the bottom of the valve a low median ridge. × 2.

Fig. 21. A profile of the rostral portion of the pedicle-valve; showing the great elevation of the median and lateral septa, the edges of which are more or less broken. × 3.
Upper Coal Measures. *Winterset, Iowa.*

PLATE 13.

Legend.
- D. Deltidium.
- C. Chilidium.
- Δ. Delthyrium.
- F. Foramen.
- F'. Groove on chilidium.
- A. Cardinal area.
  - a. Inner portion.
  - a'. Outer portion.
- b. Dental sockets.
- t. Teeth.
- j. Cardinal process.
- a. Adductor scars.
- r. Anterior diductor scars.
- r'. Posterior diductor scars.
- c. Socket walls.

LEPTÆNA, DALMAN.

Page 277.

LEPTÆNA TENUISTRIATA, Sowerby (= *L. rhomboidalis*, Wilckens).

Figs. 1, 2. Views of opposite sides of an individual in which the foramen is retained.

Hudson River group. *Oxford, Ohio.*

LEPTÆNA RHOMBOIDALIS, Wilckens.

Fig. 3. An enlargement of the beaks of an old individual; showing the great obliquity of the foramen in the pedicle-valve, which penetrates the substance of the shell at a considerable distance in advance of the apex; and also the groove in the chilidium of the opposite valve.

Fig. 4. An enlargement of the articulating apparatus of the brachial valve; showing the central groove of the chilidium, the lobes of the cardinal process and the dental sockets with their low, thick inner walls (crural plates). × 3.

Niagara group. *Waldron, Indiana.*

Fig. 6. The interior of a brachial valve; showing the aspect of the cardinal process from this point of view, the character of the muscular scars, and the strong ridge at the line of geniculation of the valve.

Fig. 7. The interior of a pedicle-valve; showing the character of the muscular impressions.

Lower Helderberg group. *Albany and Schoharie counties, N. Y.*

Fig. 8. The exterior of a pedicle-valve, in which the undulations are finer and much more numerous than usual. (The *L. undulata* of VANUXEM.)

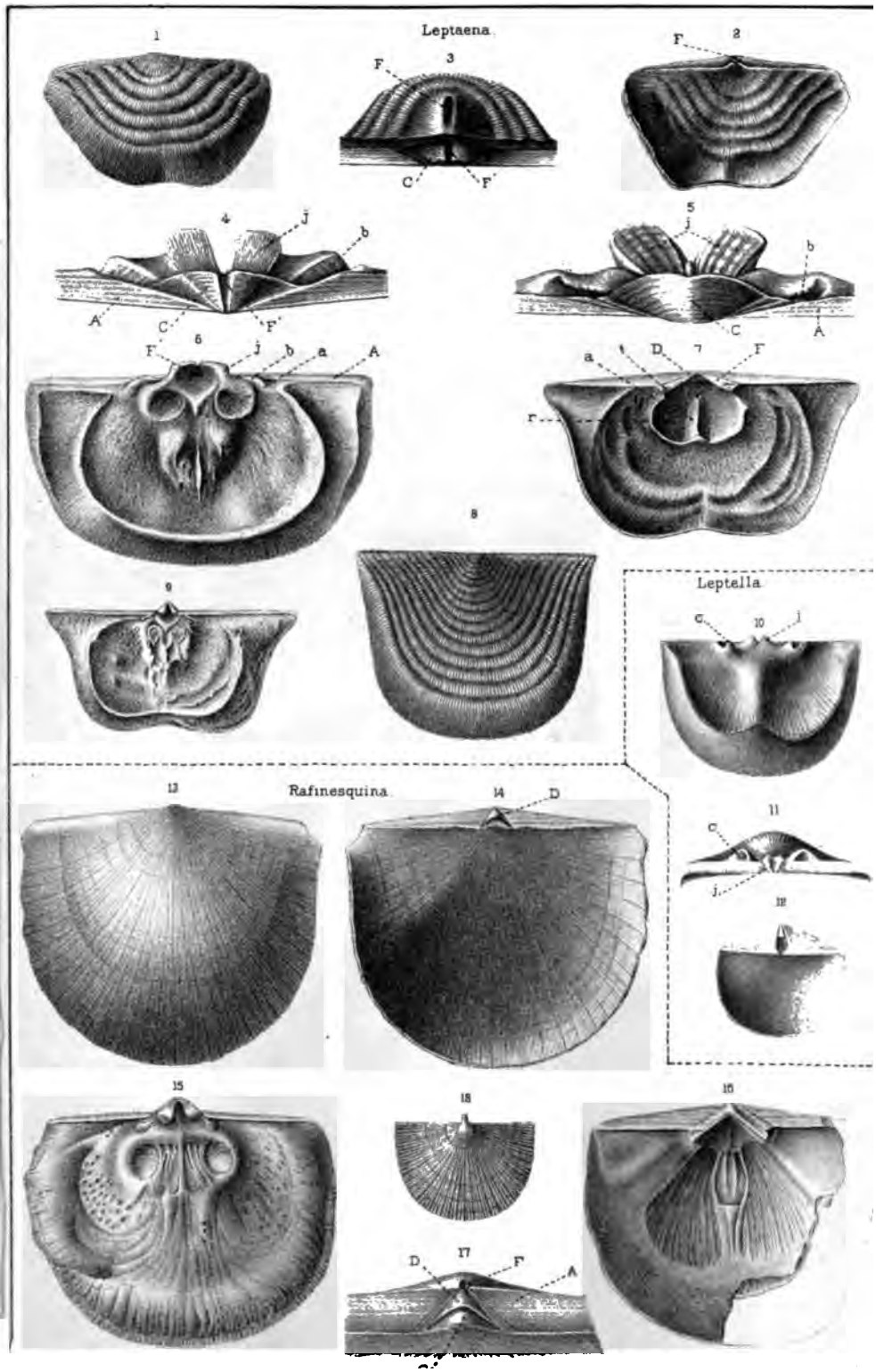
Corniferous limestone. *Western New York.*

Fig. 9. The interior of a brachial valve.

Waverly group. *Mallets' Creek, Ohio.*

BRACHIOPODA.

Generic Illustrations.



LEPTELLA, HALL.

Page 277.

LEPTELLA SORDIDA, Billings (sp.).

Fig. 10. The interior of a brachial valve. The cardinal process consists of two independent apophyses, not coalesced with the crural plates, the latter being depressed at their origin but considerably elevated at their extremities. The visceral region is concave on either side of a broad median ridge and its surface radially striated; from its anterior margin the surface of the valve is abruptly and evenly deflected. × 5.

Fig. 11. Cardinal view of the same specimen; showing the width of the area, the posterior face of the cardinal process and the elevation of the crural plates. × 5.

Fig. 12. Dorsal views of a specimen retaining both valves, and showing the outline, contour and general external characters of the species. The delthyrium of the pedicle-valve is partially cl sed by a convex deltidium. × 3.

These figures are from the original specimens of the species.

"*Point Lévis; in the upper part of the Limestone No. 2, Quebec group.*" (BILLINGS.)

RAFINESQUINA, HALL.

Page 279.

RAFINESQUINA ALTERNATA, Conrad.

Fig. 5. A posterior view of the articulating apparatus of the brachial valve. The incisor-shaped branches of the cardinal process are widely divergent, and at the bottom of the bifurcation lies a narrow callosity. The deltidium is well developed but not grooved in the middle, and the dental sockets are deeply marked. × 3.

Figs. 13, 14. Two views of a specimen presenting normal external characters.

Fig. 15. The interior of a brachial valve, with sharply-defined anterior and posterior adductor scars, and showing faint traces of recurving vascular sinuses.

Fig. 16. The interior of a pedicle-valve, in which the muscular scars have their normal character.

Fig. 17. An enlargement of a portion of the hinge area, showing the deltidium and chilidium and the retention of the foramen at maturity. × 3.
Hudson River group. *Cincinnati, Ohio.*

RAFINESQUINA ULRICHI, James.

Fig. 18. The exterior of a mature pedicle-valve in which the primitive condition of the pedicle passage as a tube or sheath is retained. This appears to be a normal feature of maturity in this species. × 2.
Hudson River group. *Covington, Kentucky.*

PLATE 14.

Legend. D. Deltidium.
△. Delthyrium.
j. Cardinal process.
s. septum.
b. Dental sockets.
r. r'. Diductor scars.
a. Anterior adductors.
a'. Posterior adductors.
o. Ovarian spaces.
v. Vascular sinuses.

GENUS STOPHEODONTA, HALL.

Page 289.

STOPHEODONTA DEMISSA, Conrad.

Fig. 1. A dorsal view of a large individual; showing no evidence of deltidium on the striated cardinal area of the pedicle-valve.

Fig. 2. A profile view of the same.

Fig. 3. The interior of a pedicle-valve; showing the muscular impressions. The center of the area has been broken away by the detachment of the cardinal process.

Fig. 4. An enlargement of the cardinal areas; showing the vertical striæ and complete obsolescence of the deltidia. × 2½.
Hamilton group. *Western New York.*

STROPHEODONTA CONCAVA, Hall.

Fig. 5. The central cardinal portion of the brachial valve of a mature individual. The lobes of the cardinal process are of great size and deeply grooved, the crural plates in a rudimentary condition and the muscular scars much thickened. × 2.

Fig. 6. A posterior view of the same specimen; showing the crenulated edges of the lobes of the cardinal process and the size of the crural plates. At *x* the base of the cardinal process has been excavated for the reception of the margin of the pedicle-valve. × 2.
Hamilton group. *Canandaigua Lake, N. Y.*

BRACHYPRION, SHALER.

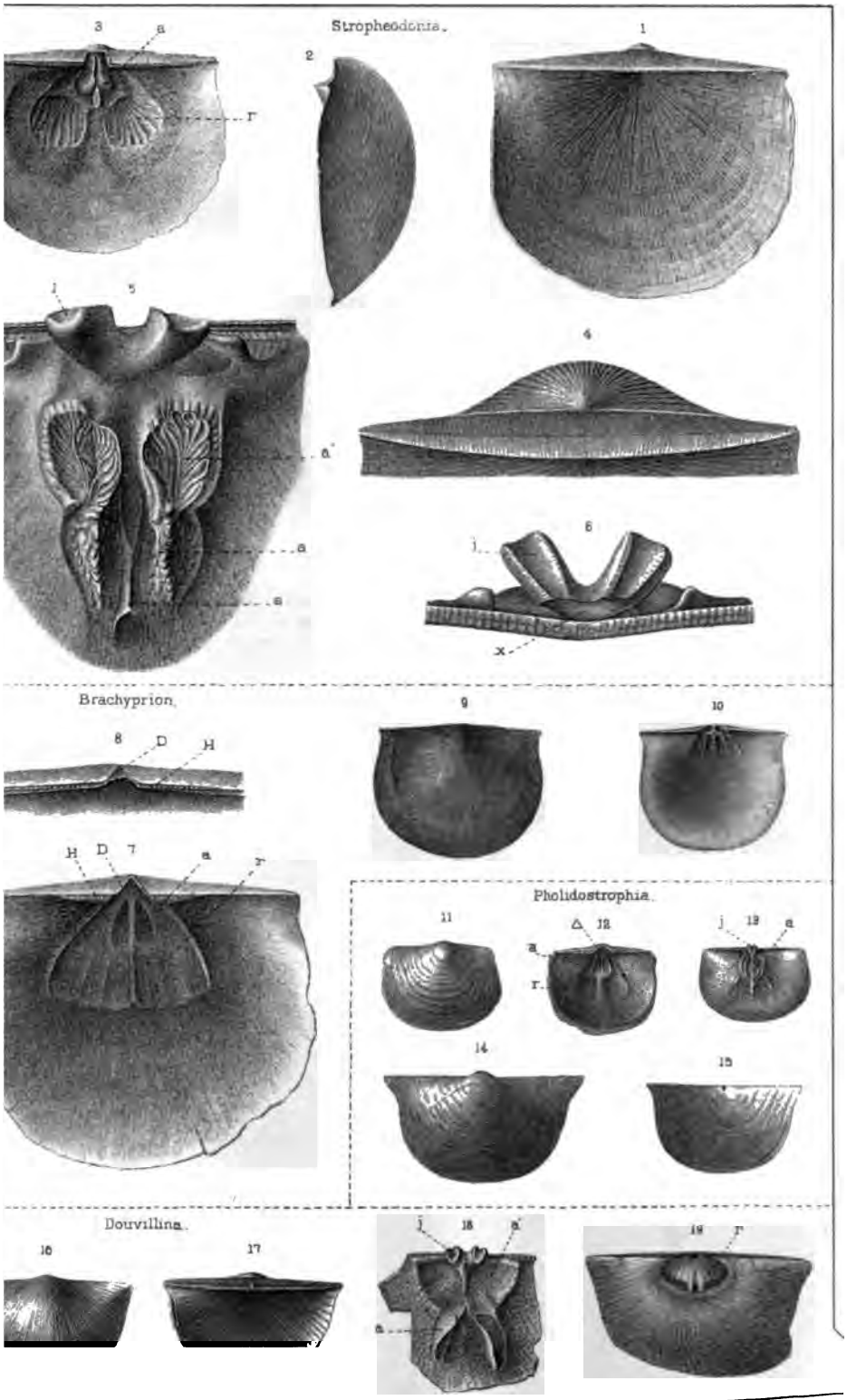
Page 281.

BRACHYPRION PROFUNDUS, Hall.

Fig. 7. The interior of a pedicle-valve having the delthyrium but partially closed, and showing the strong crenulations of the cardinal margin near the delthyrium.
Niagara group. *Waldron, Indiana.*

BRACHIOPODA.

Generic Illustrations.



BRACHYPRION VARISTRIATUS, Conrad.

Fig. 8. An enlargement of the central part of the cardinal area; showing the character of the deltidium and the short row of crenulations. × 3.

Fig. 9. The exterior of the pedicle-valve.

Fig. 10. The interior of a similar valve.

Lower Helderberg group (Tentaculite and Pentamerus limestones). *Schoharie Co., N. Y.*

PHOLIDOSTROPHIA, HALL.

Page 281.

PHOLIDOSTROPHIA NACREA, Hall.

Fig. 11. The exterior of the pedicle-valve; showing the squamous, unplicated exterior.

Fig. 12. The interior of the pedicle-valve; showing the muscular impressions and partially closed delthyrium.

Fig. 13. The interior of a brachial valve; showing the crenulated hinge-margin, cardinal process and muscular impressions.

Hamilton group. *Western New York.*

PHOLIDOSTROPHIA LINDAHLI, sp. nov.

Figs. 14, 15. The exterior of the pedicle and brachial valves.

Corniferous limestone. *Illinois.*

DOUVILLINA, ŒHLERT.

Page 281.

DOUVILLINA INÆQUISTRIATA, Hall.

Figs. 16, 17. Two views, giving the external characters of the species.

Fig. 18. The central portion of the interior of the brachial valve, enlarged to show the broad, flat posterior muscular scars and the elevated anterior muscular ridges. × 3.

Hamilton group. *Western New York.*

DOUVILLINA CAYUTA, Hall.

Fig. 19. An internal cast of the pedicle-valve; showing the short, transverse, sharply defined muscular scar.

Chemung group. *Steuben county, N. Y.*

PLATE 15.

Legend. H. Hinge-line.
D. Deltidium.
t. Teeth.
b. Dental sockets.
s. Median septum.
d. Brachial valve.
v. Pedicle-valve.
j. Cardinal process.
a. Anterior adductors.
a'. Posterior adductors.
r. Anterior diductors.
r'. Posterior diductors.
C. Chilidium.

LEPTOSTROPHIA, HALL.

Page 281.

LEPTOSTROPHIA PERPLANA, Conrad.

Fig. 1. The exterior of the pedicle-valve of an average specimen.
Hamilton group. *Western New York.*

Fig. 2. An enlargement of the interior umbonal portion of the brachial valve; showing the cardinal process and lateral muscular ridges. × 2.
Hamilton group. *Canandaigua Lake, N. Y.*

Fig. 3. A longitudinal axial section of the two valves: showing the normal curvature of the shell and the position of the cardinal process.
Hamilton group. *Western New York.*

LEPTOSTROPHIA MAGNIFICA, Hall.

Fig. 4. The interior of a pedicle-valve; showing the formation of a pedicle-pit in the delthyrium, by the union of the dental lamellæ; also the expanded, undefined muscular area.
Oriskany sandstone. *Cumberland, Maryland.*

STROPHONELLA, HALL.

Page 282.

STROPHONELLA SEMIFASCIATA, Hall.

Fig. 5. The exterior of the concave pedicle-valve.

Fig. 6. An enlargement of the central portion of the cardinal areas of conjoined valves; showing the deltidium (D) and chilidium (C).
Niagara group. *Waldron, Indiana.*

STROPHONELLA LEAVENWORTHANA, Hall.

Fig. 7. The interior of the brachial valve; showing the crenulation of the cardinal margin, the cardinal process, slightly developed crural plates and the adductor impressions.

Fig. 8. The interior of the pedicle-valve; showing the crenulation of the hinge-margin, the closed delthyrium and the arrangement of the muscular scars.

BRACHIOPODA.

Generic Illustrations.

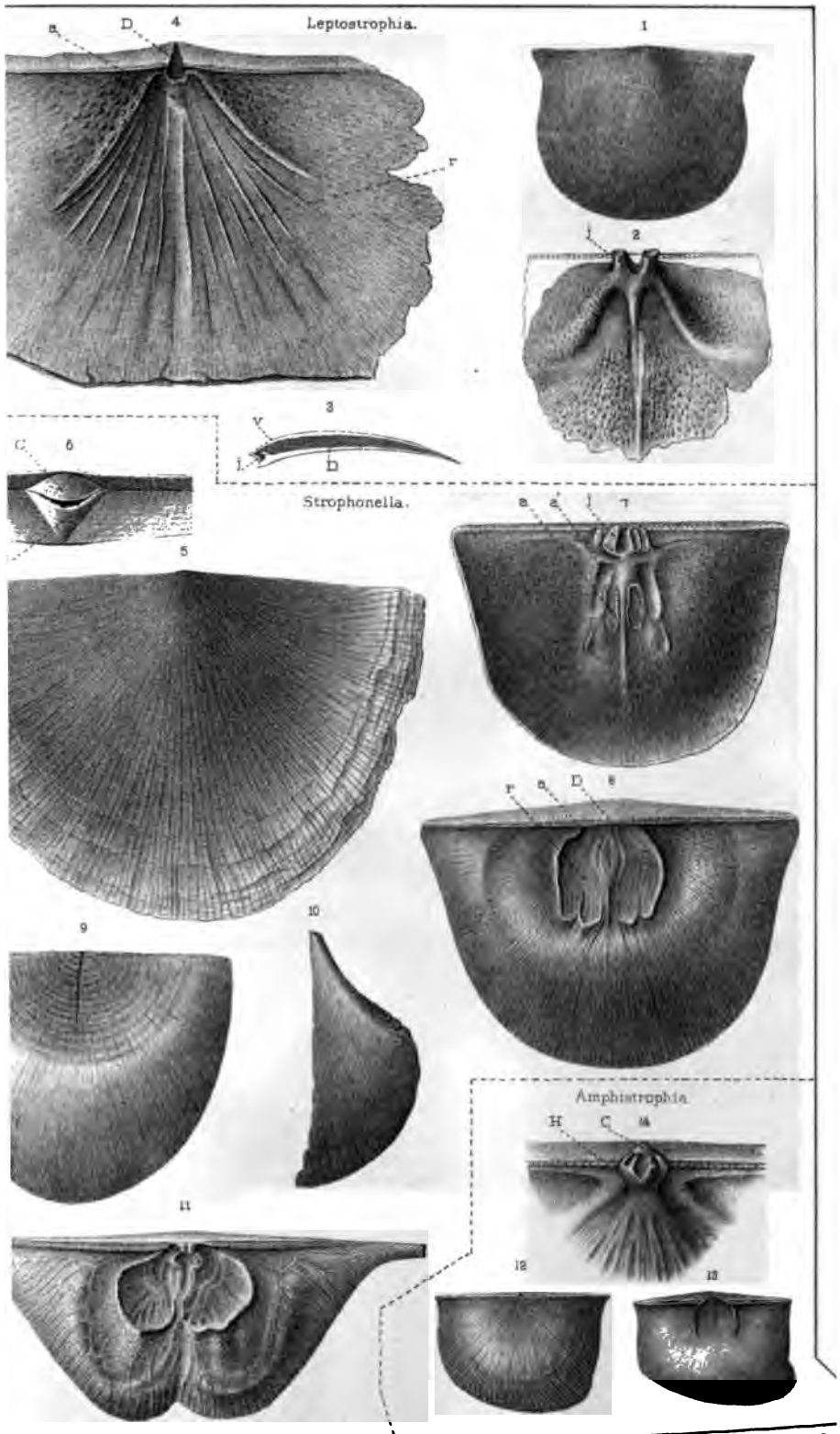


Fig. 9. The exterior of a brachial valve.

Fig. 10. A profile of the same specimen; showing the concavity in early growth stages, followed by great convexity and strong geniculation.

Lower Helderberg group. *Albany county, N. Y.*

STROPHONELLA CÆLATA, Hall.

Fig. 11. The interior of a brachial valve in an unusually fine state of preservation. The flabellate muscular scars have the form usual to this genus and similar to that characterizing DOUVILLINA. The crenulations of the hinge-line do not extend to the extremities of the cardinal area; a feature of frequent occurrence in many of the earlier species of STROPHEODONTA. The impressions of the pallial sinuses are also distinctly shown.

Chemung group. *Near Addison, N. Y.*

AMPHISTROPHIA, HALL.

Page 283.

AMPHISTROPHIA STRIATA, Hall.

Fig. 12. A dorsal view of conjoined valves.

Fig. 13. The interior of a pedicle-valve; showing the extension of the dental lamellæ along the muscular area and the crenulation of the cardinal margins near the delthyrium.

Fig. 14. An enlargement near the central portion of the brachial valve; showing the lobed cardinal process, the huge crenulations and the small chilidium.

Niagara group. *Waldron, Indiana.*

PLATE 16.

Legend. D. Deltidium.
A. Cardinal area.
I. Umbo-lateral slopes.
t. Teeth.
d. Dental lamellæ.
b. Dental sockets.
j. Cardinal process.
c. Crura.
s. Median septum.
a. Adductor scars.
r. Diductor scars.
fp. Socket walls.

STROPHOMENA, Rafinesque.

Page 283.

STROPHOMENA PLANUMBONA, Hall, = *Strophomena rugosa*, Rafinesque (de Blainville).

Fig. 1. A dorsal view; showing the usual form and proportions of the species.

Fig. 2. The interior of a brachial valve. On account of the great convexity of this valve, the cardinal process is projected upward at an unusual angle.

Fig. 3. The interior of a pedicle-valve; showing the usual character of the muscular markings.
Hudson River group. *Lebanon, Ohio.*

Fig. 4. An enlargement of the cardinal process and crural plates. × 2.

Fig. 5. The corresponding portion of the opposite valve; showing the irregularly crenulated character of the surface of the teeth. × 2.
Hudson River group. *Oxford, Ohio.*

STROPHOMENA WISCONSINENSIS, Whitfield.

Fig. 6. A profile of conjoined valves; showing the retrorsion of the beak of the pedicle-valve.

Fig. 7. A cardinal view of the same specimen.
Hudson River group. *Wilmington, Illinois.*

ORTHOTHETES, FISCHER DE WALDHEIM.

Page 284.

ORTHOTHETES CHEMUNGENSIS, Conrad, var. PANDORA, Billings.

Fig. 8. A dorsal view; showing the cardinal area and deltidium of the pedicle-valve.

Fig. 10. The interior of a pedicle-valve; showing the low deltidium, unsupported teeth, the adductor and diductor scars.
Corniferous limestone. *Caledonia, N. Y.*

BRACHIOPODA.

Generic Illustrations.

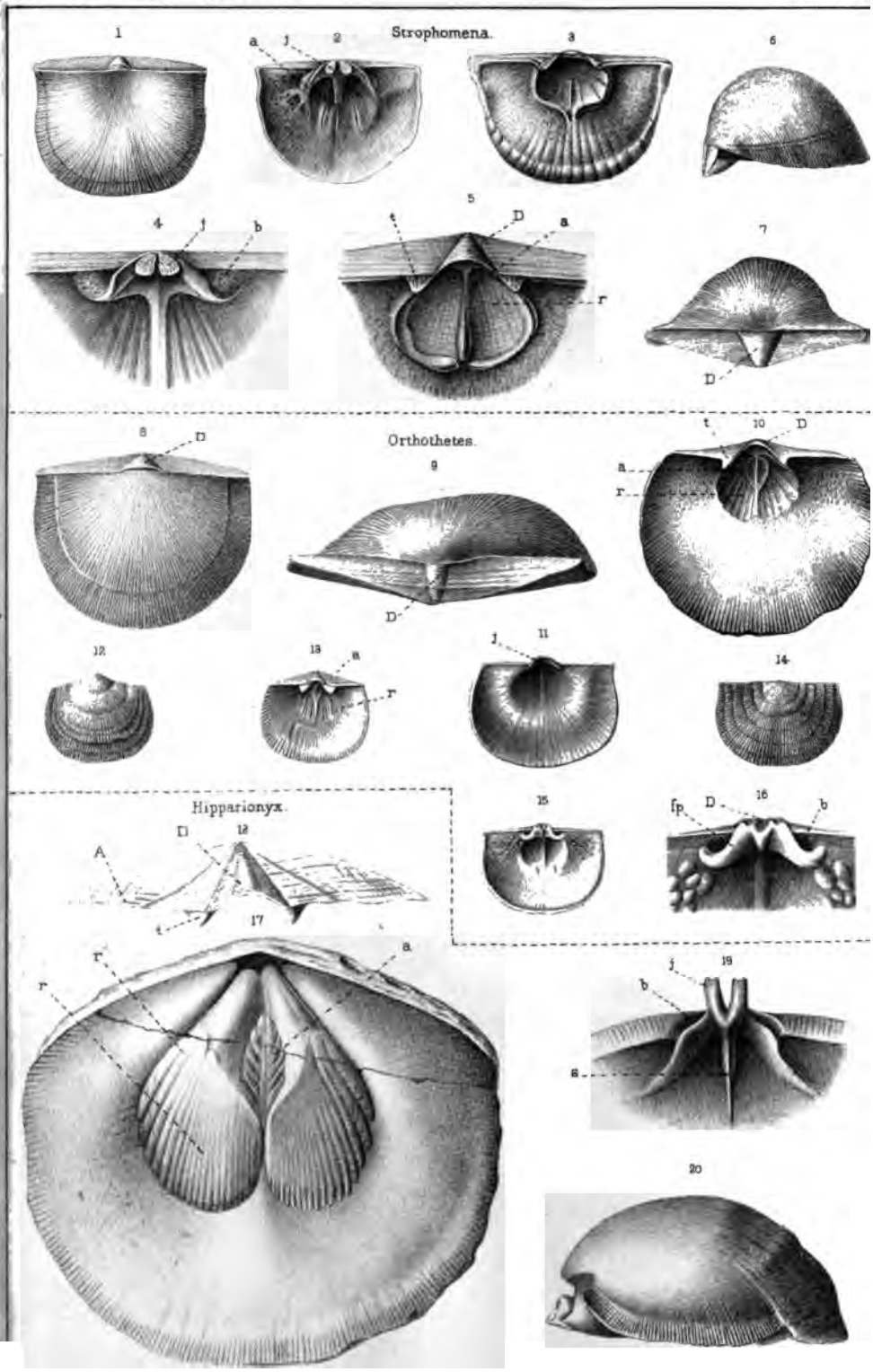


PLATE 14.

Legend. D. Deltidium.
△. Delthyrium.
j. Cardinal process.
s. septum.
b. Dental sockets.
r. r'. Diductor scars.
a. Anterior adductors.
a'. Posterior adductors.
o. Ovarian spaces.
v. Vascular sinuses.

GENUS STOPHEODONTA, HALL.

Page 299. 250

STOPHEODONTA DEMISSA, Conrad.

Fig. 1. A dorsal view of a large individual; showing no evidence of deltidium on the striated cardinal area of the pedicle-valve.

Fig. 2. A profile view of the same.

Fig. 3. The interior of a pedicle-valve; showing the muscular impressions. The center of the area has been broken away by the detachment of the cardinal process.

Fig. 4. An enlargement of the cardinal areas; showing the vertical striæ and complete obsolescence of the deltidia. × 2¼.
Hamilton group. *Western New York.*

STROPHEODONTA CONCAVA, Hall.

Fig. 5. The central cardinal portion of the brachial valve of a mature individual. The lobes of the cardinal process are of great size and deeply grooved, the crural plates in a rudimentary condition and the muscular scars much thickened. × 2.

Fig. 6. A posterior view of the same specimen; showing the crenulated edges of the lobes of the cardinal process and the size of the crural plates. At *x* the base of the cardinal process has been excavated for the reception of the margin of the pedicle-valve. × 2.
Hamilton group. *Canandaigua Lake, N. Y.*

BRACHYPRION, SHALER.

Page 281.

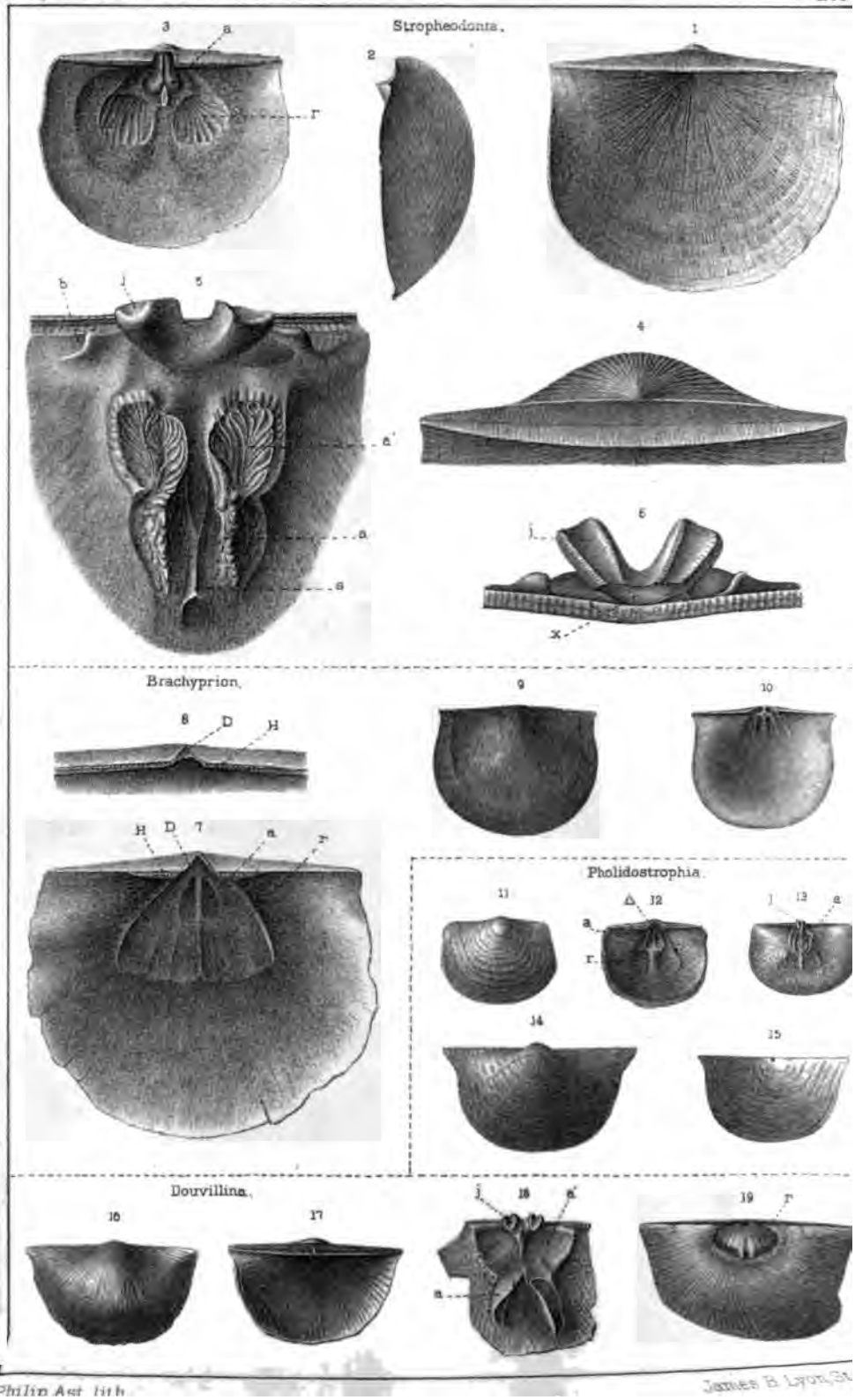
BRACHYPRION PROFUNDUS, Hall.

Fig. 7. The interior of a pedicle-valve having the delthyrium but partially closed, and showing the strong crenulations of the cardinal margin near the delthyrium.
Niagara group. *Waldron, Indiana.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate



Philip Aet. lith. James B. Lyon, Co.

Fig. 11. Cardinal view of a distorted specimen, with an unusually high cardinal area.
Upper Coal Measures. *Lawrence county, Kansas.*

Fig. 12. A longitudinal section of the valves; showing the extent of the dental lamellæ and crural plates.

Fig. 13. An enlargement of the cardinal process; showing the extreme elevation of the lobes and the crural plates.
Upper Coal Measures. *Winterset, Iowa.*

STREPTORHYNCHUS, King.

Page 288.

Streptorhynchus pelargonatus, Schlotheim.

Figs. 14, 15, 16. Profile, anterior, and cardinal views of a specimen which retains the shell; showing the contour and general external character of the species. × 2.

Fig. 17. An internal cast of the pedicle-valve; showing the form of the muscular area, without evidence of a median septum. × 2.

Fig. 18. The interior of the cardinal portion of the articulated valves; showing the dental ridges and inner surface of the deltidium, the cardinal process, crural plates and the character of the articulation. × 5.
Permian System. *Pösneck, Silesia.*

PLATE 18.

Legend.
F. Foramen.
ps. Deltidium.
c. Crura.
j. Cardinal process.
d. Dental lamellæ.
a. Anterior adductors.
a'. Posterior adductors.
r. Diductors.

TRIPLECIA, HALL.

Page 989.

TRIPLECIA EXTANS, Emmons.

Fig. 1. A dorsal view of an individual of average dimensions.

Fig. 2. An anterior view of the same.
Trenton limestone. *Lowville, N. Y.*

Fig. 3. The cardinal area of the pedicle-valve; showing the apical foramen and the convex deltidial covering.
Trenton limestone. *Carlton Island, N. Y.*

Fig. 4. A cardinal view of a brachial valve; showing the bifurcated cardinal process extending into the matrix.
Trenton limestone. *Middleville, N. Y.*

TRIPLECIA NUCLEUS, Hall.

Figs. 5, 6. Cardinal and profile views of a normal individual, the former showing the foramen and deltidium of the pedicle-valve. × 2.
Trenton limestone. *Middleville, N. Y.*

TRIPLECIA ORTONI, Meek.

Fig. 7. The exterior of a brachial valve.

Fig. 8. Cardinal view of a specimen having the valves in conjunction; showing the cardinal area, foramen and deltidium.

Fig. 9. The external cardinal area of conjoined valves. × 3.

Fig. 10. The central cardinal portion of an old and thickened brachial valve. The tips of the cardinal process and of one of the crura have been broken.

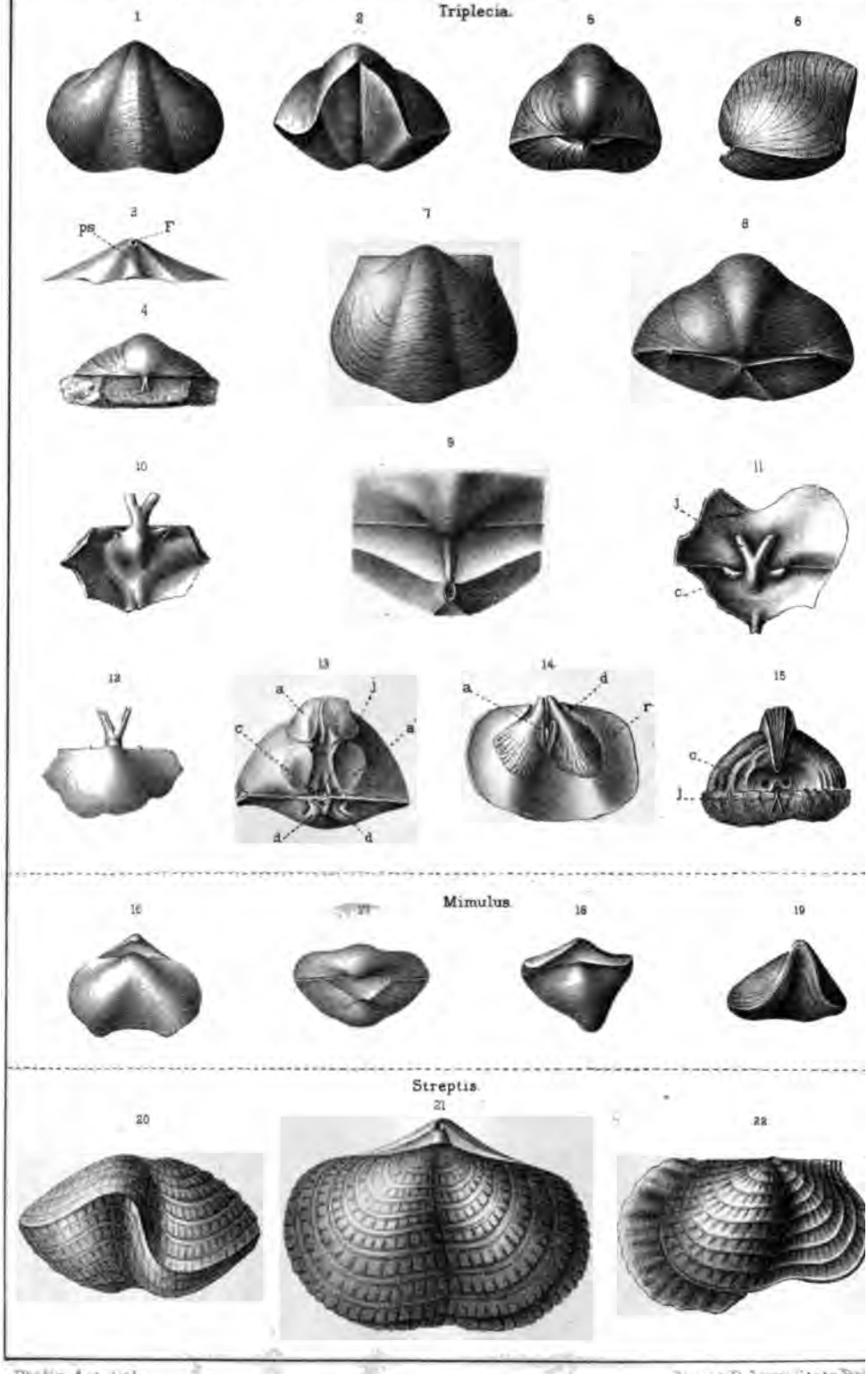
Fig. 11. Interior of the cardinal region of conjoined valves; showing their mode of articulation.

Fig. 12. Posterior view of the cardinal process; showing the grooves on the outer face of its branches.
Clinton group. *Dayton, Ohio.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate



Philip Ast. lith.

James B. Lyon, State Pr.

TRIPLECIA INSULARIS, Eichwald.

Fig. 13. Cardinal view of an internal cast of the conjoined valves; showing, in the brachial valve, the impressions of the anterior and posterior adductors, the crura and cardinal process, and, in the pedicle-valve, the extent of the dental lamellæ.

Caradoc sandstone. *Ty-Isaf, Wales.*

TRIPLECIA WENLOCKENSIS, Davidson.

Fig. 14. A cast of the interior of the pedicle-valve; showing the adductor and diductor muscular scars and the impressions of the dental lamellæ.

Wenlock limestone. *England.*

TRIPLECIA SPIRIFEROIDES, McCoy.

Fig. 15. A cardinal view of an internal cast of a brachial valve; showing the impressions of the crura and the bifurcated cardinal process.

Caradoc sandstone. *North Wales.*

MIMULUS, BARRANDE.

Page 289.

MIMULUS PERVERSUS, Barrande.

Fig. 16. Dorsal view of the shell; showing the sinus on the brachial valve and the uninterrupted cardinal area of the pedicle-valve.

Fig. 17. Cardinal view of the same specimen.

Etagé E_2. *Listice, Bohemia.*

MIMULUS WALDRONENSIS, Miller and Dyer.

Fig. 18. Cardinal view of an adult individual, the type specimen. The cardinal area shows no trace of deltidium or foramen. × 3.

Fig. 19. Anterior view of the same specimen; showing the peculiar asymmetry of the shell.

Niagara group. *Waldron, Indiana.*

STREPTIS, DAVIDSON.

Page 259.

STREPTIS GRAYI, Davidson.

Figs. 20, 21. Anterior and dorsal views; showing the asymmetry of the valves, the concentric ornamentation and the perforated deltidium. × 5. (DAVIDSON.)

Wenlock limestone. *Dudley, England.*

Fig. 22. A brachial valve which retains the lamellar expansion at one of the growth-lines. × 4.

Etagé E_2. *Lodenitz, Bohemia.*

PLATE 19.

Legend. D. Deltidium.
C. Chilidium.
t. Teeth.
d. Dental lamellæ.
j. Cardinal process.
c. Crura.
br. Brachial ridges.
a. Anterior adductor scars.
a'. Posterior adductor scars.
r. Diductor scars.
x. Scar of attachment.

PLECTAMBONITES, PANDER.

Page 290.

PLECTAMBONITES TRANSVERSALIS, Dalman.

Fig. 1. The exterior of a pedicle-valve. × 2.
Niagara group. *Lockport, N. Y.*

Fig. 2. An internal cast of the pedicle-valve; showing the muscular and vascular impressions. × 2.
Niagara dolomites. *Near Milwaukee, Wisconsin.*

Fig. 3. The interior of a brachial valve; showing the elongate adductor scars. × 2.
Niagara group. *Lockport, N. Y.*

PLECTAMBONITES SERICEA, Sowerby.

Fig. 4. A dorsal view of conjoined valves; showing the area and closed delthyrium of the pedicle-valve.

Fig. 5. The interior of the brachial valve; showing the depressed visceral disk, the muscular scars and the cardinal process.

Fig. 6. The interior of the pedicle-valve; showing the divergent muscular scars.

Fig. 7. An enlargement of the cardinal process; showing its union with the crural plates and the abrupt termination of the latter. The process is simple, but on its posterior face appears trilobed from coalescence with the ends of the crural plates. × 3.
Trenton horizon. *Mineral Point, Wisconsin.*
Also Trenton limestone and Hudson River group, New York.

CHRISTIANIA, HALL.

Page 290.

CHRISTIANIA SUBQUADRATA, Hall.

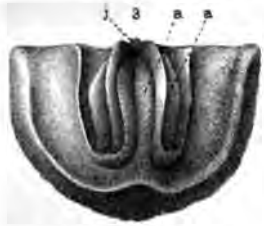
Figs. 8, 9. Two views of the pedicle-valve; showing its elongate form, incurvature, and smooth or squamous exterior. × 2.

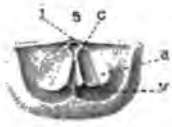
Fig. 10. Cardinal view of the brachial valve; showing the bilobed cardinal process, widely divergent crural plates, the prominent longitudinal and transverse muscular ridges inclosing the impression of the adductor muscles. × 3.

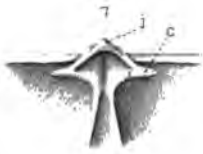
BRACHIOPODA.

Generic Illustrations.

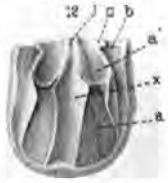
Plectambonites.

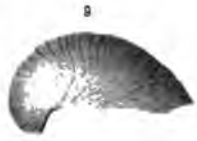




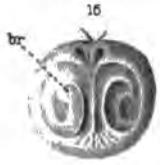


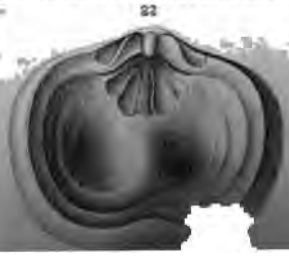
Christiania.





Leptaenisca.





Davidsonia.

James B. Lyon, State Pr

Fig. 11. The interior of the pedicle-valve; showing the open delthyrium, muscular walls and scars.

Fig. 12. The interior of a brachial valve; showing the bilobed cardinal process and the quadruple adductor scar, divided by high, vertical muscular walls.

Fig. 13. The exterior of the brachial valve; showing the cardinal process and edges of the crural plates.

Lower Helderberg group. *Perry county, Tennessee.*

LEPTÆNISCA, Beecher.

Page 291.

Leptænisca concava, Hall.

Fig. 14, The exterior of a pedicle-valve; showing the scar at the beak, due to the attachment of the shell.

Fig. 15. Cardinal view of an imperfect brachial valve preserving the character of the cardinal process, which is deeply quadrilobate. × 3.

Fig. 16. The interior of a brachial valve, somewhat imperfect about the margins and cardinal process, but showing the spiral brachial ridges and the thin median septum. × 2.

Lower Helderberg group. *Near Clarksville, N. Y.*

Leptænisca adnascens, Hall.

Fig. 17. A pedicle-valve attached by nearly its entire outer surface to the interior of a valve of *Orthis oblata*. The specimen shows the dental lamellæ and median ridge dividing the muscular area. × 3.

Fig. 20. A specimen retaining both valves, attached to *Orthis perelegans*. × 4.

Lower Helderberg group. *Near Clarksville, N. Y.*

Leptænisca tangens, Hall.

Figs. 18, 19. Opposite sides of a pedicle-valve attached to a twig of Trematopora. × 3.

Fig. 21. The exterior of a pedicle-valve in which the rugose growth has obscured the median sinus. The deep umbonal scar is due to attachment to some bryozoan. × 3.

Lower Helderberg group. *Near Clarksville, N. Y.*

DAVIDSONIA, Bouchard.

Page 292.

Davidsonia Verneuiliana, Bouchard.

Figs. 22, 24. Interiors of the brachial and pedicle-valves respectively.

Fig. 23. Profile of an attached specimen retaining the two valves. (Davidson.)

PLATE 20.

Legend.
- D. Deltidium.
- C. Chilidium.
- st. Cardinal tubes.
- t. Teeth.
- b. Dental sockets.
- s. Septum.
- j. Cardinal process.
- a. Anterior adductors.
- a'. Posterior adductors.
- r. Anterior diductors.
- r'. Posterior diductors.
- v. Brachial ridges.

CHONETES, Fischer de Waldheim.

Page 204.

Chonetes cornuta, Hall.

Fig. 1. A view of the pedicle-valve. × 2.
Clinton group. *Sodus Bay, N. Y.*

Chonetes setigera, Hall.

Fig. 2. Pedicle-valve of a larger specimen with finer striæ. × 2.
Marcellus shales. *Near Caledonia, N. Y.*

Chonetes mucronata, Hall.

Fig. 3. A pedicle-valve with long, extremely divergent spines. × 2.
Marcellus shales. *West Avon, N. Y.*

Chonetes Acutiradiata, Hall.

Fig. 4. The pedicle-valve.
Corniferous limestone. *Williamsville, N. Y.*

Chonetes Verneuiliana, Norwood and Pratten.

Figs. 5, 6. Two views; showing the strong median constriction. × 2.
Coal Measures. *Illinois.*

Chonetes mesoloba, Norwood and Pratten.

Fig. 7. A pedicle-valve; showing the median fold. × 2.
Coal Measures. *Illinois.*

Chonetes coronata, Conrad.

Fig. 8. A view of the brachial valve; showing the cardinal area and deltidium.

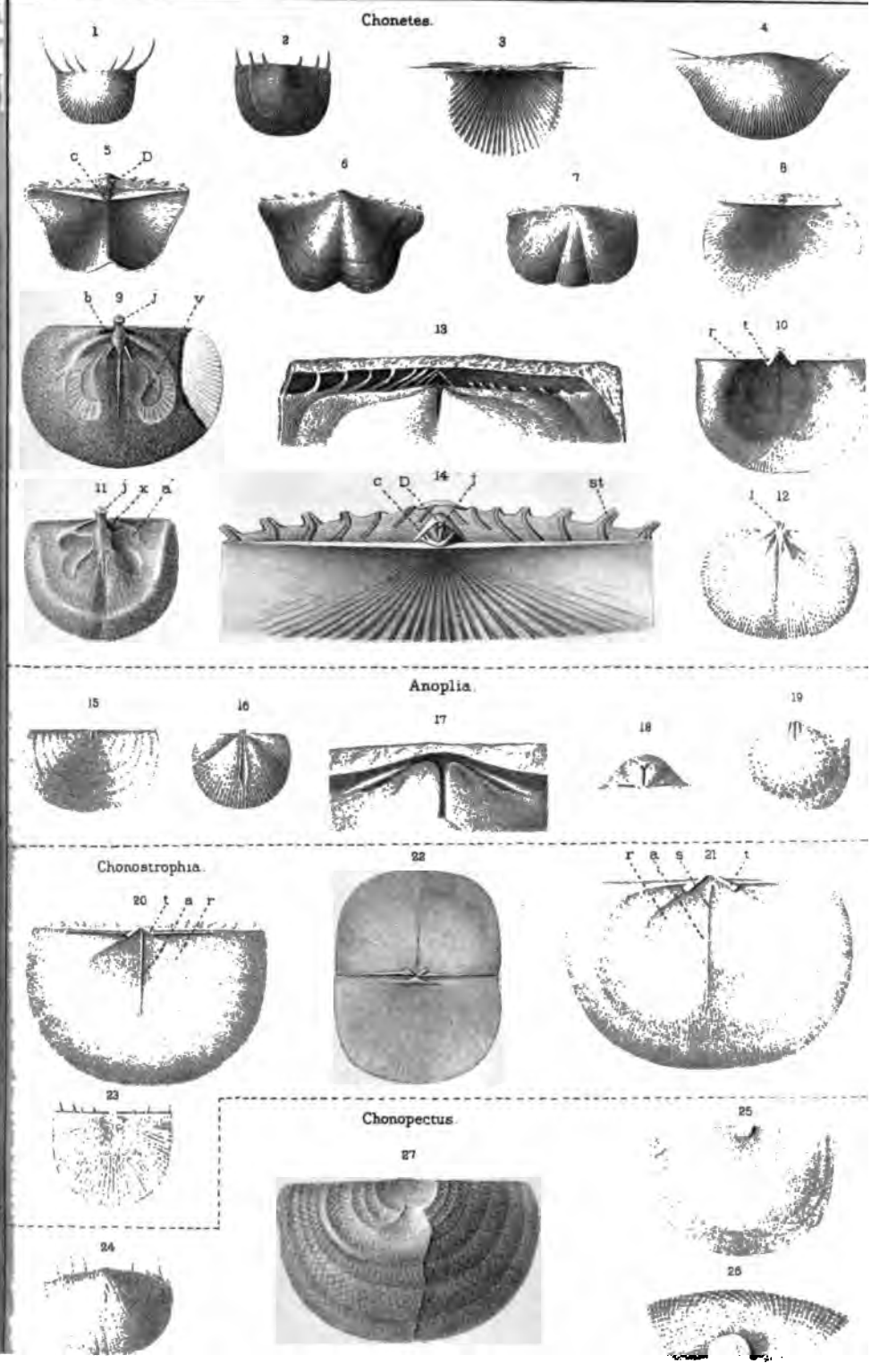
Fig. 9. The interior of a brachial valve; showing the cardinal process, muscular scars and brachial ridges.
Hamilton group. *York, N. Y.*

Fig. 12. The interior of another brachial valve; showing more distinctly the lobation of the cardinal process.
Hamilton group. *Western New York.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 2



CHONETES LINEATA, Conrad.

Fig. 10. The interior of a pedicle-valve; showing the area, teeth and muscular impressions. × 2.

Corniferous limestone. *Western New York.*

CHONETES DEFLECTA, Hall.

Fig. 11. The interior of a brachial valve. × 2.

Hamilton group. *Western New York.*

CHONETES AMAZONICA, Derby.

Fig, 13. An enlargement of an internal cast of the pedicle-valve, which retains the filling of the spine-tubes crossing the cavity left by the removal of the cardinal portion of the valve. × 3.

Coal Measures. *Rio Tapajos, Brazil.*

CHONETES SCITULA, Hall.

Fig. 14. An enlargement of the cardinal portion of the valves; showing the hollow spines and the curving course of the spine-tubes through the substance of the cardinal area of the pedicle-valve. × 8.

Hamilton group. *Western New York.*

ANOPLIA, HALL.

Page 293

ANOPLIA NUCLEATA, Hall.

Fig. 15. The exterior of the brachial valve; showing the smooth surface. × 3.

Oriskany sandstone. *Jones county, Illinois.*

Fig. 16. The interior of the brachial valve; showing its similarity to that of CHONETES. × 2.

Fig. 17. The central cardinal portion of an internal cast of the pedicle-valve; showing the filling of the oblique cardinal tubes which do not penetrate to the external surface. × 6.

Oriskany sandstone. *Columbia county, N. Y.*

Fig. 18. Cardinal view of an internal cast of the pedicle-valve, retaining the impressions of the extremely oblique dental lamellæ, and the short median septum. × 3.

Oriskany sandstone. *Albany county, N. Y.*

Fig. 19. Internal cast of a pedicle-valve; showing the impression of the short median septum, and the pustulose character of the pallial region. × 3.

Oriskany sandstone. *Columbia county, N. Y.*

CHONOSTROPHIA, HALL.

Page 294.

CHONOSTROPHIA COMPLANATA, Hall.

Fig 20. The interior of a pedicle-valve; showing the reversed convexity of the shell, the flabellate muscular area, conspicuous median septum and cardinal spines.

Fig. 21. Another exterior of a similar valve in which the spines are apparently wanting.

Oriskany sandstone. *Albany county, N. Y.*

CHONOSTROPHIA HELDERBERGIA, Hall.

Fig. 22. A specimen in which the valves are opened, exposing their internal surfaces. The shell may have been somewhat flattened in fossilization, but still shows the reversal of the relative convexity of the valves, the cardinal area, teeth and faint median septum of the pedicle-valve, and the finely lineate surface. The cardinal process is not retained with sufficient distinctness to permit its accurate delineation.

Lower Helderberg group. *Near Clarksville, N. Y.*

CHONOSTROPHIA REVERSA, Whitfield.

Fig. 23. The exterior of a pedicle-valve which retains the cardinal spines. ×2.

Upper Helderberg group. *Cayuga, Ontario.*

CHONOPECTUS, HALL.

Page 295.

CHONOPECTUS FISCHERI, Norwood and Pratten.

Fig. 24. A small pedicle-valve, retaining the cardinal spines, and showing, over the body of the shell, some divergent impressions which may be of vascular origin.

Fig. 25. A pedicle-valve having the normal proportions of the species, and showing a few spine bases on the cardinal margin. The reticulate surface markings, as on this specimen, do not usually extend over the pallial region, which is covered by exceedingly fine, often irregular, radiating striæ.

Fig. 26. Posterior view of the umbonal region in the same specimen, enlarged to show character of the cicatrix. ×2.

Yellow sandstones. *Burlington, Iowa.*

Fig. 27. The exterior of a pedicle-valve which retains the reticulate surface ornamentation and a large scar of attachment. ×2.

In strata referred to the age of the Waverly group. *Warren, Pennsylvania.*

PLATE 21.

Legend.
- A. Cardinal area.
- D. Deltidium.
- C. Chilidium.
- t. Teeth.
- b. Dental sockets.
- j. Cardinal process.
- v. Brachial ridges.
- a. Anterior adductors.
- a'. Posterior adductors.
- r. Diductors.

STROPHALOSIA, KING.

Page 295.

STROPHALOSIA TRUNCATA, Hall.

Fig. 1. The interior of a brachial valve; showing the cardinal process.

Fig. 2. The exterior of a brachial valve; showing the convex umbo, corresponding to the truncation of the apex of the opposite valve. × 2.

Figs. 3, 4. Two views of a pedicle-valve; showing the truncation of the beak. × 2.

Marcellus shales. *Western New York.*

STROPHALOSIA MURICATA, Hall.

Fig. 5. Two views of a pedicle-valve; showing the cicatrix of attachment.

Fig. 6. An internal cast of the pedicle-valve; showing the muscular impressions.

Chemung group *Meadville, Pennsylvania.*

STROPHALOSIA RADICANS, Winchell.

Fig. 7. The calyx of a single polypite of *Acervularia Davidsoni*, to which is attached a pedicle-valve of this species, its adherent spines running between the septa of the coral. × 3.

Fig. 8. A pedicle-valve situated in a cavity among the polypites of *Acervularia Davidsoni*. There is a slight attachment by the apex of the valve but fixation is mainly effected by the spines. Those on the cardinal margin creeping along the surface of a polypite, and several of those which are on the body of the valve crossing the cavity, their extremities being somewhat obscured by the matrix of the specimen. These spines appear to increase slightly in diameter from the surface of the shell outward and their surface is marked with fine concentric annulations. × 3.

Fig. 9. A pedicle-valve attached by its entire outer surface and spines to a FISTULIPORA. × 2.

Hamilton group. *Little Traverse Bay, Michigan.*

ith.

STROPHALOSIA CORNELLIANA, Derby.

Fig. 10. The interior cardinal portion of the pedicle-valve; showing the area, deltidium; teeth and muscular scars. × 3.
Coal Measures. *Bomjardim, Brazil.*

STROPHALOSIA GERARDI, King.

Fig. 11. View of the shell; showing the lamellose brachial valve, cardinal areas, deltidia and the umbonal cicatrix. (DAVIDSON.)
Permian. (?) *Spiti, India.*

AULOSTEGES, VON HELMERSEN.

Page 297.

AULOSTEGES WANGENHEIMI, de Verneuil.

Fig. 12. The interior of a brachial valve. (DAVIDSON.)

Fig. 13. The cardinal area of the pedicle-valve; showing the spiniform tubercles on the surface of the deltidum. × 2.

Fig. 14. Dorsal view of conjoined valves; showing the character of the exterior. (DAVIDSON.)
Permian. *Orenburg, Russia.*

PRODUCTELLA, HALL.

Page 298.

PRODUCTELLA COSTATULA, Hall.

Figs. 15, 16, 17. Three views of a pedicle-valve.
Chemung group. *Chemung county, N. Y.*

PRODUCTELLA ONUSTA, Hall.

Fig. 18. The interior of a brachial valve; showing cardinal process, dental sockets, muscular and brachial impressions.
Chemung group. *Cattaraugus county, N. Y.*

Fig. 19. Cardinal view of an internal cast of the pedicle-valve; showing the muscular scars.
Chemung group. *Conewango, N. Y.*

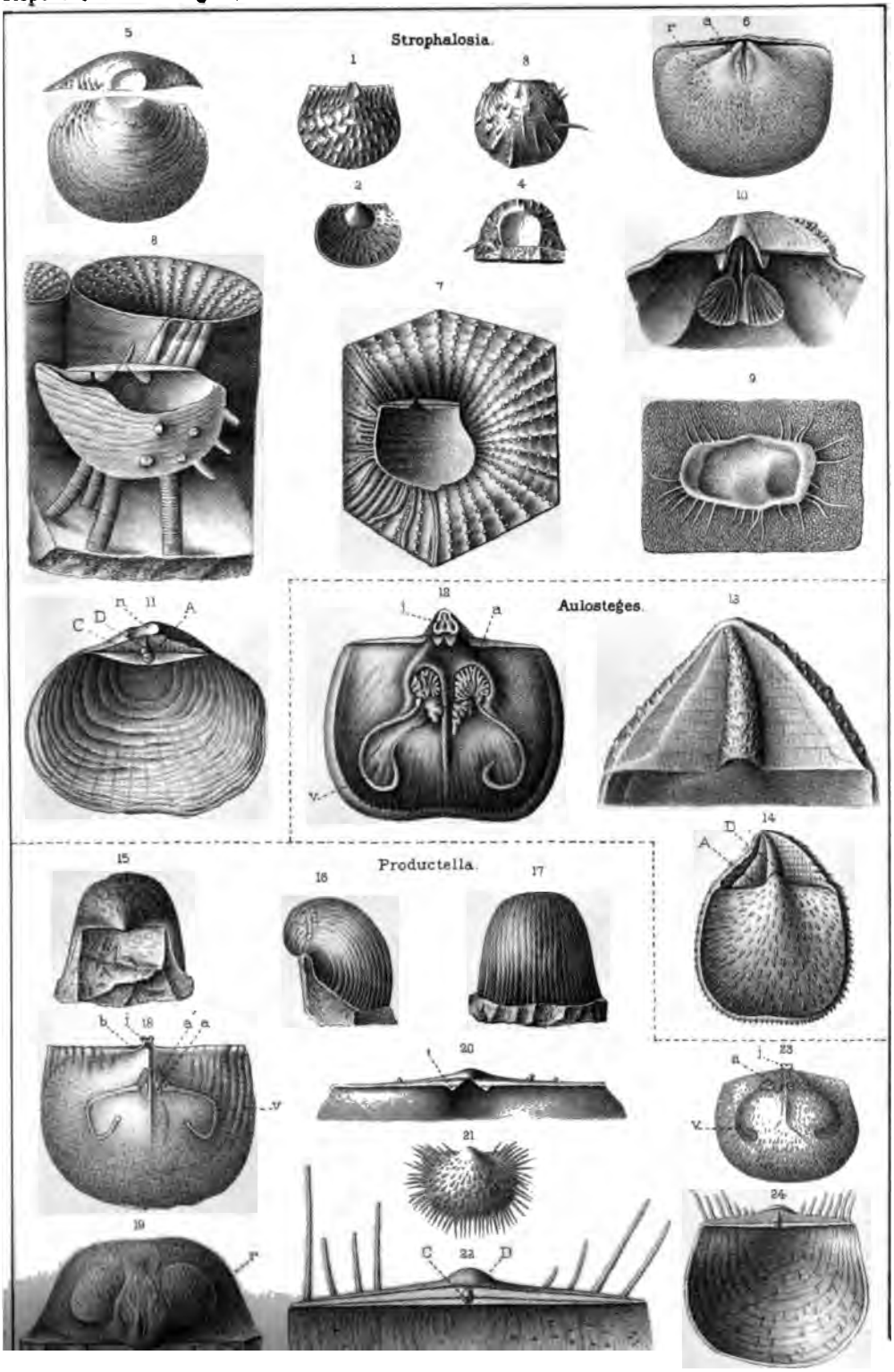
PRODUCTELLA PYXIDATA, Hall.

Fig. 20. The cardinal portion of the pedicle-valve; showing the area and teeth. × 2.

Fig. 23. The interior of a brachial valve; showing the cardinal process, muscular scars and brachial ridges.
Choteau limestone. *Pike county, Missouri.*

BRACHIOPODA.

Generic Illustrations.



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PRODUCTELLA HYSTRICULA, Hall.

Fig. 21. The exterior of the pedicle-valve; showing the fine, closely crowded spines.

Chemung group. *Chautauqua county, N. Y.*

PRODUCTELLA, sp. (?)

Fig. 22. Cardinal view of an undetermined species, which retains the cardinal areas and deltidia of both valves and the marginal spines of the pedicle-valve. × 2.

Chemung group. *Greenwood, N. Y.*

PRODUCTELLA PRODUCTOIDES, Murchison.

Fig. 24. View from the brachial valve; showing the cardinal area and deltidia, and the marginal spines of the pedicle-valve. (DAVIDSON.)

Upper Devonian. *North Devon, England.*

PLATE 22.

Legend. j. Cardinal process.
s. Septum.
v. Brachial ridges.
a. Anterior adductors.
a'. Posterior adductors.
r. Diductors.

PRODUCTUS, Sowerby.

Page 297.

Productus costatus, Sowerby.

Fig. 1. The exterior of a pedicle-valve; showing the general character of the specimens referred to this species in this country.
Coal Measures. *Winterset, Iowa.*

Productus semireticulatus, Martin.

Fig. 2. Cardinal view of an internal cast of the pedicle-valve; showing the impression of the cardinal area, the posterior and anterior adductor and the diductor muscles.
Coal Measures. *Newcastle, Ohio.*

Fig. 3. Posterior view of the cardinal process; showing the complete coalescence of the inner divisions of the two lateral lobes. × 3.

Fig. 5. The central portion of a brachial valve, which retains with unusual distinctness the muscular and brachial impressions.
Coal Measures. *Bomjardim, Brazil.*

Productus symmetricus, McChesney.

Fig. 4. A portion of the brachial valve enlarged to show the structure of the brachial ridges or areas. The surface within the curved ridges is covered with irregular clusters of fine granules, which become more widely scattered in the central region about the median septum. The origin of this structure, as well as that seen in figures 16 and 18, has not been ascertained. × 2.
Upper Coal Measures. *Near Kansas City, Missouri.*

Producutus (? auriculatus, Swallow).

Fig. 6. The exterior of a pedicle-valve, the surface of which is free of spines except along the cardinal margin.
Coal Measures. *Near Kansas City, Missouri.*

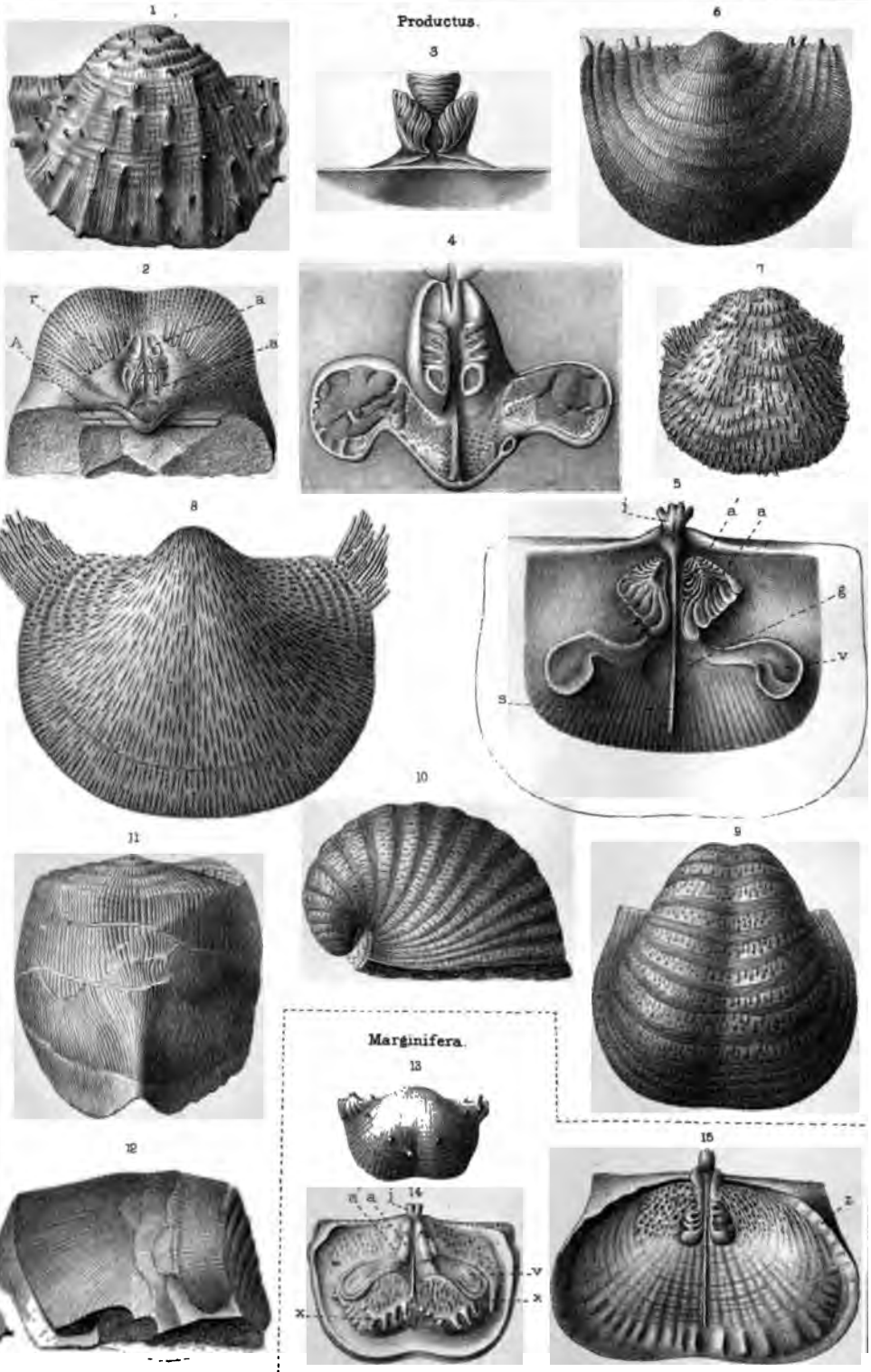
Productus Nebrascensis, Owen (= *P. aspersus*, McChesney).

Fig. 7. The exterior of a specimen; showing the great abundance of short spines.
Coal Measures. *La Salle, Illinois.*

BRACHIOPODA.

Generic Illustrations.

Report State Geologist, 1891. Plate 22



Philip Ast lith.

James B. Lyon, State Printe

PRODUCTUS NEWBERRYI, Hall.

Fig. 8. The exterior of a pedicle-valve; showing the numerous spine-bases and retaining the spines at the cardinal extremities.
Waverly sandstone. *Medina, Ohio.*

PRODUCTUS PUNCTATUS, Martin.

Figs. 9, 10. Two views of a pedicle-valve; showing the spiniferous bands which form concentric annulations.
Coal Measures. *Mississippi Valley.*

PRODUCTUS .EQUICOSTATUS, Shumard.

Figs. 11, 12. The exterior of a specimen from which the upper or visceral portion of the pedicle-valve has been broken; showing the flattened surface of the lower valve and the peculiar mode of growth on the anterior margin, a tendency to infolding which attains its extreme manifestation in the completed tube of PROBOSCIDELLA.
Coal Measures. *Nebraska.*

MARGINIFERA, WAAGEN.

Page 298.

PRODUCTUS (MARGINIFERA) SPLENDENS, Norwood and Pratten (*P. longispinus*, Sowerby).

Fig. 13. View of a specimen; showing numerous ribs with a few scattered spine-bases, and a nacreous shell texture.
Upper Coal Measures. *Winterset, Iowa.*

Fig. 14. The interior of a brachial valve; showing the cardinal process, muscular impressions and brachial ridges. At *xx* is a row of short spinules which project from the inner surface of the shell, a feature more highly developed here than in any other species observed. The submarginal ridges which characterize WAAGEN'S subgenus MARGINIFERA are not highly developed in this specimen. × 2.
Coal Measures. *La Salle, Illinois.*

PRODUCTUS (MARGINIFERA) LASALLENSIS, Worthen.

Fig. 15. The interior of a brachial valve; showing the character of the internal ridge (*z*), distinguishing the subgenus MARGINIFERA. In this species probably occurs the most extreme development of this feature among the American productids. × 2.
Upper Carboniferous. *La Salle, Illinois.*

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